3/21

INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

S-E-C-R-E-T 14966 - 11

[redacted]

50X1-HUM

COUNTRY	USSR	REPORT	[redacted]
SUBJECT	MIG-21FL Aircraft: English Translation of the Technical Description of the R-2L Radar	DATE DISTR.	March 1966
		NO. PAGES	1 A-Proc
		REFERENCES	[redacted]
DATE OF INFO.	[redacted] MAR 1966		
PLACE & DATE ACQ.	[redacted]		

50X1-HUM

50X1-HUM

THIS IS UNEVALUATED INFORMATION. SOURCE GRADINGS ARE DEFINITIVE. APPRAISAL OF CONTENT IS TENTATIVE.

[redacted]

[redacted] English translation of a Soviet manual for the R-2L radar carried by the MIG-21FL (modified FISHBED D) aircraft, entitled The R-2L Radar, Technical Description, VII.003.206SP (Stantsiya R-2L, tekhnicheskoye opisaniye, VII.003.206SP) [redacted]

50X1-HUM

5
4
3
2
1

S-E-C-R-E-T

GROUP 1 Excluded from automatic downgrading and declassification

[redacted]

50X1-HUM

STATE	DIA	ARMY	NAVY	AIR	NSA	XAID NIC	OCR	SA
		Army/FSTC	Air/FTD	Navy/STIC	Air/AFNIEBA	OEL		

(Note: Field distribution indicated by "#".)

INFORMATION REPORT INFORMATION REPORT

50X1-HUM [redacted]

THE R-2L RADAR

TECHNICAL DESCRIPTION

VI 1.003.206 SP

(English Translation)

SECRET

[redacted] 50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

50X1-HUM

SECRET

THE R-2L RADAR

TECHNICAL DESCRIPTION

VI 1.003.206 Sp

50X1-HUM

S-E-C-R-E-T

50X1-HUM

CONTENTS

S-E-C-R-E-T

50X1-HUM

[redacted] 50X1-HUM

CONTENTS (Continued)

---*---

S-E-C-R-E-T

50X1-HUM [redacted]

LIST OF ABBREVIATIONS USED IN THE TEXT

(TRANSLITERATED CYRILLIC)

A.	- attenuator
Avt.z.d.	- range automatic lock-on
AZ	- automatic lock-on
APChK	- klystron AFC
ARU	- AGC
AS	- automatic tracking
Balans NDU	- elevation I-F amplifier current balance in ranging system
b/s	- aircraft circuit
V	- switch, toggle
VP	- vibrapack
v.ch.	- radio frequency
G	- monitor jack on unit escutcheon
Gv	- air-tight lead, inlet, bushing
GON	- reference voltage generator
D	- diode, target pulse delay relative to transmitter trigger pulse
D_z	- lock-on maximum range
$D_{k.p.}$	- end-of-search range
Dmax	- launch zone maximum range
Dmin	- launch zone minimum range
$D_{n.p.}$	- start-of-search range
Dob	- scanning maximum range
Dop.sb.	- dangerous closing range
DVS	- airspeed data unit
Dr	- choke coil
DU	- ranging system
ZL	- locked-on beam
ZP	- launch zone
In	- induction coil
IP	- measuring instrument
K	- monitoring point within a unit; receiving channel sensitivity
Kl	- contact terminal
Kn	- button or knob
KV	- limit switch
KZA	- monitor recorder
KP	- contact unit, current supply
KSV	- standing wave ratio
L	- electron tube

S-E-C-R-E-T

Lev.1/2L	- left half of tube...
Lz	- delay line
LN	- incandescent light (signal light)
NL	- neon light
MB	- mechanical blocking
MU	- magnetic amplifier
O	- heating
"O" mode	- scanning mode
"O" display	-"break off" display
OK	- deflecting coil
P	- switch, block, plate
"P" light	- interference indicator light
"P" display	- interference display
Pr	- fuse
Pr.1/2 L	- right half of tube...
PUPCh	- I-F preamplifier
R	- relay
RD	- pressure data unit
RRChK	- klystron manual frequency control
Sn	- selsyn
SP	- interference tracking
T	- temperature control, adder circuit adding factor, pulse repitition rate
T9	- pulse repetition rate in scan mode
T19	- pulse repetition rate in aiming mode
T30	- scanning rate
TG	- tach generator
Tr	- transformer
U	- power supply
UZLz	- ultrasonic delay line
UPT A, N,K,OS	- dc amplifier for azimuth, elevation, tilt, feedback
UPT [sic]	- I-F amplifier [normally UPCh]
F	- radio frequency plug
Sh	- plug connector
ShARU	- automatic gain stabilization (AGS) or sensitivity time control (STC)
EM	- electromagnet
EP	- electric drive

S-E-C-R-E-T

(LATIN, GREEK, AND MISCELLANEOUS)

P_{max}	- pulse maximum power
λ	- wavelength
λ_s	- operational wavelength
R	- resistor
ρ	- characteristic impedance
σ	- coefficient of total secondary emission
t_o	- time corresponding to transmitter triggering
t_{sh}	- noise factor
$T_{k.p.}$	- pulse duration corresponding to end of search
$T_{k.s.}$	- phantastron pulse duration corresponding to end of tracking
$T_{n.p.}$	- pulse duration corresponding to start of search
T_o	- range-sweep-intensity pulse duration, range sweep duration in scanning mode
T_p	- range-sweep-intensity pulse duration in aiming mode
T_{pr}	- range sweep duration in aiming mode
T_s	- R-F pulse duration in scan
T_{sl}	- R-F pulse duration in automatic tracking
$T_{sh.s.}$	- wide-gate noise pulse duration
U_{vkh}	- input voltage
U_{max}	- maximum-range voltage, depending on closing speed and flight altitude
U_{min}	- minimum-range voltage, depending on closing speed
$U_{n-n_{min}}$	- voltage corresponding to present flight altitude
U_{st}	- voltage at stabilizer output
U_v	- voltage corresponding to speed of closing with target
$U_{Vo\ max}$	- maximum-range voltage at zero closing speed
$U_{Vo\ min}$	- minimum-range voltage at zero closing speed
U_1, U_2, U_3	- jump voltage
U_1	- voltage corresponding to middle line
U_2	- voltage corresponding to lower line
U_3	- voltage corresponding to upper line
W	- magnitude amplifier winding; electromagnetic winding
Z	- waveguide impedance
%m	- percentage modulation of target video pulses

S-E-C-R-E-T

α - aircraft bank angle
α_l - extreme left position of antenna on a line
α_p - extreme right position of antenna on a line
C - capacitor
E - electric field strength
$E_{d.zap.}$ - tube blocking voltage
ΔE - voltage increment
fget - local oscillator frequency
f_M - magnetron operating frequency
fpr - IF
frez - resonant frequency
fs - reflected signal frequency
Δf - pass band
H - flight altitude; magnetic field strength
Hmax - maximum flight altitude
In - current of load
Ist - current across gas stabilizer
I_1 - primary electron current
I_2 - secondary electron current
ΔI - increase of current flowing through half a tube
L - inductance
P_i - pulse power

S-E-C-R-E-T

50X1-HUM

50X1-HUM

50X1-HUM

PART ONE

OPERATING PRINCIPLE OF THE R-2L, DESIGN AND LAYOUT ON AIRCRAFT

Chapter One

PURPOSE, OPERATING PRINCIPLE, AND BASIC TACTICAL-TECHNICAL DATA ON THE R-2L

Section 1. Purpose and Brief Information on Operation of the Air Target Interception Complex

The R-2L airborne radar is designed to function in a complex of equipment for intercepting air targets on a fighter-interceptor.

Regardless of visibility, the radar provides for: a. automatic scanning of space in the forward hemisphere sector with respect to azimuth, elevation, and up to Dob with respect to range; b. semiautomatic target lock-on and automatic target tracking with respect to angular coordinates and range; c. target display in scanning and aiming modes (automatic tracking) on the same electronic indicator; d. aiming and firing of homing missiles; e. an "otvorot" (break off) signal for dangerous closing range; f. automatic calculation and transmission to indicator of possible firing zone depending on altitude and closing speed; g. operation in the presence of random pulse noise in both scanning and automatic tracking modes, and operation in the presence of passive noise directed toward the interceptor in the lock-on and automatic tracking mode; h. signalling the presence of smooth noise interference and, after switchover to noise operating mode, indicating and automatic tracking of the source of smooth noise interference with respect to angular coordinates; i. automatic switchover to scanning mode when source of smooth noise interference ceases to operate; j. automatic photography of the indicator screen in flight.

The system complex for air-target interception is designed for the destruction of enemy aircraft. The equipment in the complex provides for day and night all-weather combat activity.

Depending on target altitude and speed the complex provides for interception and destruction of a target at various ranges from the installation being protected.

S-E-C-R-E-T

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

50X1-HUM

Section 2. Operation During Air-Target Interception

At the moment the interceptor is at distance Dob (scanning range) from target, the pilot concentrates his attention on the radar indicator. The indicator provides for high intensity of markers on the screen and facilitates detection and clear visibility of a target.

To monitor radar operation and pilot function, equipment for photographing the indicator screen starts up as radiation of sounding pulses into space begins. In the scanning mode the indicator screen is photographed at the rate of a frame every 2.5 seconds.

In scanning mode the radar beam covers the forward hemisphere for azimuth with three equal lines (upper, middle, lower).

From the moment a target pip is observed the aircraft is piloted in accordance with the radar screen (fig. 2).

The antenna and, hence, the scanning zone are stabilized with respect to tilt within the limits plus or minus 70°.

Tilt-stabilization of the antenna prevents loss of target at large bank angles. During closing, when the interceptor-to-target distance becomes equal to D_z (lock-on maximum range), the target marker on the indicator enters the rectangle on the light filter.

From this moment the target can be locked on for automatic tracking, for which purpose the pilot presses the "Zakhvat" (lock on) button on the aircraft control handle and holds it until target lock-on.

The appearance of the "bird" on the indicator screen signifies target lock-on and the "Zakhvat" button can be released. From the moment of lock-on the radar is on automatic target tracking by angle and range; on the indicator screen the pilot sees the "bird" with center mark ("marker"), two range marks symmetrically situated relative to the "marker" and two shaded areas on the "bird" -- the zones of permissible firing (fig. 3). The position of the center mark on the indicator screen defines the position of the target in space.

The distance between the center mark and either range mark shows the range to target. For a successful attack the pilot, while closing, flies the plane so that the center mark on the "bird" (or the crosschair of the aiming sweep) does not go beyond the limits of the small circle on the indicator screen.

S-E-C-R-E-T

50X1-HUM

The position of the aircraft with respect to a bank, in both scanning and aiming modes is not shown on the indicator screen since the high intensity of the markers enables the pilot to glance away from the indicator to look at the horizon instrument.

A missile can be launched at any instant during the time the range markers are in the permissible firing zones with the special signal coming in; to fire the pilot presses the "pusk" (fire) button on the aircraft control lever.

When closing with the target at range $D_{op.sb}$ (dangerous closing range) the order to terminate the attack is signaled by the "O" (break-off) light on the indicator.

If necessary to drop the target the pilot presses the "Sbros" (break-off) button and the radar goes on scanning mode.

Section 3. Radar Operation Under Interference Conditions

a) Random Interference

Provision is incorporated in the radar for suppression of random [literally "non-sychronous"] pulse interference. It does not show up on the screen during operation and has no effect on the set's parameters. Hence the pilot is simply unaware of whether the interference does or does not exist.

b) Passive Interference [chaff]

When attacking a target which is dropping passive interference into the rear hemisphere the pilot sees on the indicator screen the pips from the target and from each cloud of passive interference. Depending on the frequency with which the interference is dropped and the speed of the target, the pips from the interference clouds may elide on the screen into a line divergent along the azimuth (a tail) or may appear as discrete pips. In the overall pattern of markers the former, which is at maximum range, is the target marker and the aircraft should be piloted according to that marker with respect to azimuth.

The radar incorporates provision for passive noise suppression, allowing lock-on and automatic tracking of a target which is putting out passive interference. Closing speed on the passive interference is considerably greater than closing speed on the target. The principle involved in the suppression of passive interference is based on selection

S-E-C-R-E-T

50X1-HUM

[redacted]

according to speed.

In an attack on a slow-flying target, closing speed on which is high and which is perceived by the radar as passive interference, normal automatic tracking is upset. In this case the pilot can cut off the passive noise suppression with the toggle switch "Zashchita R-2L ot passivnykh pomekh" (R-2L passive noise suppression).

c) Smooth Noise Interference

The "P" (pomekha-interference) display on the radar indicator lights up in presence of smooth noise interference. Thereupon, if there is no target pip the pilot moves the selector switch on the TsD-41UTPM radar control panel to "Pomekha" position. The radar indicator screen displays an artificial target marker characterizing the position of the target (noise interference source) with respect to azimuth and elevation. Present range to target is not indicated. The pilot flies the aircraft according to the azimuth and elevation into the lock-on zone and executes lock-on procedure. The position of the "bird" on the indicator screen in aiming mode corresponds to target position in angular coordinates. The zones of possible firing and the present range to target are not indicated on the "bird". Firing is executed on command from the ground. During all of this the "P" display on the indicator screen is on. When the smooth noise interference discontinues the radar automatically switches to scanning mode; the "P" display goes out.

S-E-C-R-E-T

50X1-HUM

[redacted]

50X1-HUM

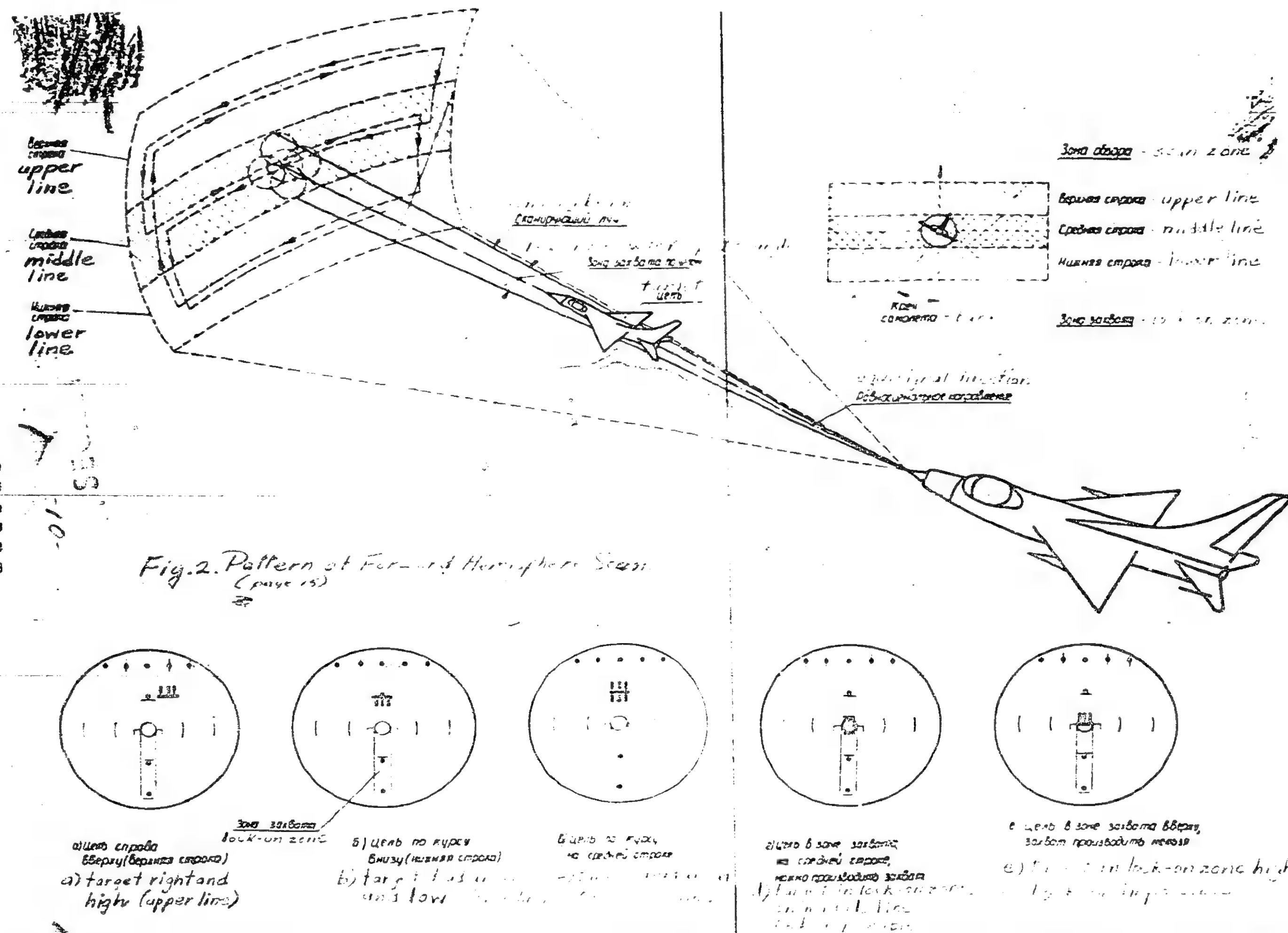


Fig. 2. Pattern of Forward Hemisphere Scan (page 15)

-10-

S-E-C-R-E-T

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

50X1-HUM

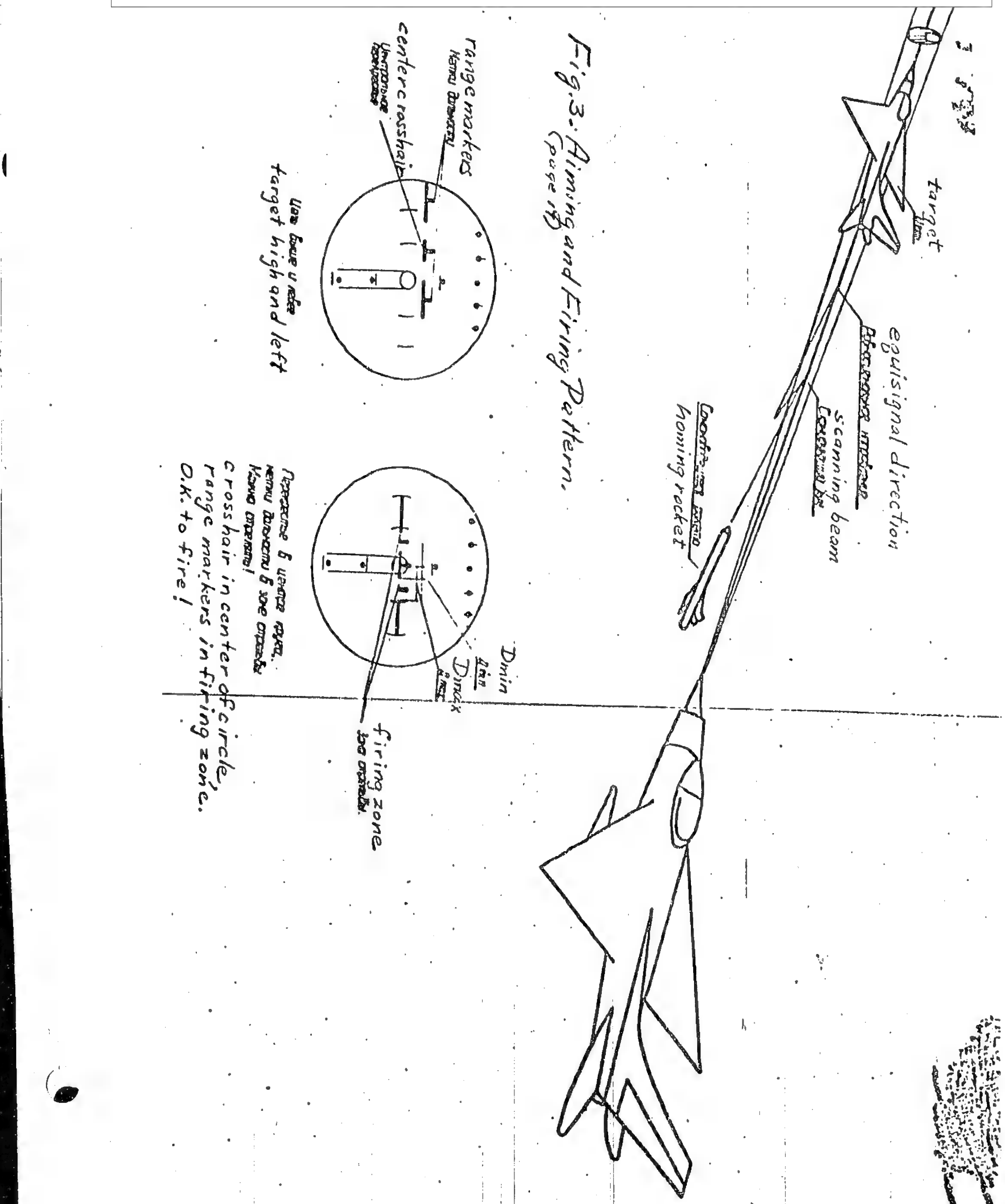


Figure 3. Aiming and Firing Pattern

S-E-C-R-E-T

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

d) Ground Noise

Protection of the radar against signals created by reflection from the ground at low altitudes is ensured by pulse-width suppression of the received signals. The radar also provides for protection against pulse noises created by reflections from the ground and arriving at the receiver during the second operating cycle. In order to protect the radar against such signals during flights at low altitudes, the pilot deactivates the lower scanning line by means of the toggle switch marked "Zashchita R-2L ot zemli" (protection of the R-2L against ground [noises]).

Section 4. Make-up of the Radar Set

The radar includes the following units and assemblies.

1. Antenna TsD-31TP, which forms a narrow bean and scans the forward hemisphere or automatically tracks a target in the aiming mode.
2. Receiver-transmitter unit TsD-32TK, which shapes the pulses which trigger the magnetron oscillator, generates high-intensity RF pulses, provides for conversion and preliminary amplification of the received signals, and automatically maintains a constant intermediate frequency.
3. Receiver TsD-33, which provides the main amplification of the received signals, controls the gain automatically, modulates the received signals with respect to time, and protects the set against random noise in the automatic tracking mode.
4. Indicator TsD-34TPM, which creates on the screen of a cathode-ray tube a radar display of the forward hemisphere zone which is seen by the antenna. If targets are present when operating in the scanning mode, the target echos are observed with elevation markers "Verkh-Niz" (top - bottom) in corresponding positions on the screen.

In the aiming mode a "bird" with present-range markers appears on the screen of the indicator. The position of the "bird" on the screen corresponds to the elevation and azimuth of the tracked target.

5. Sweep unit TsD-46, which shapes the sawtooth currents for the range sweep and azimuthal sweep in the scanning mose, as well as the range sweep, azimuthal sweep and elevation sweep in the aiming mode; the unit creates a permissible firing zone which is proportional to the closing speed with the target and the flight altitide of the interceptor.
6. Unit TsD-36 for shaping synchronizing pulses and "Verkh-Niz" (top - bottom) markers, which shapes trigger pulses for the receiver, transmitter, and "Verkh-Niz" markers corresponding to the position of the target in space with respect to elevation in the scanning mode.
7. Range unit TsD-37, which provides for search and tracking of targets with respect to range, protects the set against passive-ECM, and generates D_{min} and D_{max} voltages which are dependent upon the closing speed with the target and the flight altitude of the interceptor.
8. Power supply unit TsD-38, which supplies the entire set with the following rectified and stabilized voltages: +300 v; +250; +150 v; -250 v.

50X1-HUM

[redacted]

9. Antenna control unit TsD-40TK, which controls the azimuthal and elevation movements of the antenna reflector through the magnetic amplifiers of unit TsD-44TP.

10. Control panel TsD-41UTPM, which combines the controls for the set.

11. Test panel TsD-41KTP, which combines the lelments for testing and monitoring the set.

12. Connection box TsD-42, which is designed for connecting all the units of the set to each other and for automatically switching the entire series of circuits to the various operating modes of the set.

13. Magnetic amplifier and antenna tilt stabilization unit TsD-44TP, which amplifies the signals which control the antenna in the azimuthal, elevation, and tilt directions, stabilizes the tilt of the antenna in the scanning mode, and sets the antenna at the zero tilt position after range lock-on of the target.

14. Unit TsD-25TK for synchronization and noise-suppression, with UZLZ (ultrasonic delay line), which time-synchronizes the operation of all channels of the radar, provides suppression of random pulse noises and ground reflections, and shapes the integrated target pulses which are required for operation of the indicator.

15. Noise interference display unit TsD-26TK, which in the presence of smooth noise interference sends a signal to the "P" display of unit TsD-34TPM; in the "pomekha" (noise) or interference mode, the unit generates a pulse which opens the receiver and an artificial target pulse, and generates signals which switch on the tracking mode; in the "kontrol'" (monitor) mode, the unit shapes a pulse which triggers transmitter TsD-32TK.

16. "Antenna-Equivalent" switch TsD-29TPM, which channels energy to the antenna or to the antenna equivalent upon command from control panel TsD-41UTPM.

17. Photographic unit 34FVNP-T (camera PAU-473-1 with focusing device), which permits monitoring the operation of the radar and the performance of the pilot while in flight.

18. Photography synchronization unit VSYu, which automatically controls the operation of the camera.

19. DVS, connection box, which serves for calibration of the DVS (air speed data unit).

20. Filters for units 32TK, VSYu, and PAU-473-1.

21. Rheostat for controlling megnetron current.

22. Shock-absorbing frame.

23. Set of connecting cables.

24. Installation frame in aircraft.

The following aircraft instruments and power sources are used in operating the radar in flight:

1. Altitude data unit VTsD-30, which generates a continuously changing voltage proportional to the flight altitude of the interceptor and feeds it to the fire control computer, and also generates a voltage of +27 v at flight altitudes of 14 km and greater.

S-E-C-R-E-T

[redacted]

50X1-HUM

2. Air speed data unit DVS. [end of page 23]
[page 24 of Russian text missing]
[beginning page 25]

The set of cables supplied with the radar, in addition to the multi-conductor and coaxial cables, includes adapter cables 19F, 19-1F, 20F, aircraft cable assembly, hermetically sealing plugs, and extension cables 19k, 19-1k, 20k, 16-1k, 15-2k and 16k.

Section 5. Basic Tactical and Technical Data

a. Basic Tactical Data

1. Scanning maximum range	D_{ob}
2. Lock-on maximum range	D_z
3. Time required to prepare set for operation after turning on supply voltages	3-4 min
4. Noise stability of set:	
with random pulse noises, the detection and tracking range	is not reduced
with passive-ECM dispersed into rear hemisphere of target aircraft,	lock-on and tracking of target is ensured
with smooth noise interference,	ensures search for and and lock-on of target without indication of range

b. Basic Technical Data

1. Operating frequency range	$f_M \pm 30$ Mc
2. Peak power	P_{pulse}
3. Pulse duration:	
in scanning mode	T_s
in automatic tracking mode	T_{s1}
4. Pulse repetition rate:	
in scanning mode	corresponds to ultrasonic delay line (T9), cps
in automatic tracking mode	T19 cps
5. Sensitivity of receiving channel for reception of signal plus noise	K

S-E-C-R-E-T

6. Scanning frequency	T30
7. Position of target in vertical plane is reproduced by means of "Verkh-Niz" (top-bottom) artificial markers	
8. Radar supply voltage:	
from aircraft circuit	+27 v ± 10%
from stabilized frequency source	115 v, 400 cps
from three-phase voltage source	36 v, 400 cps
9. Power consumption:	
from 27-v aircraft circuit	not more than 12 a
from 115-v, 400 cps source	not more than 11.5 a
from 115-v, 600-900 cps source	not more than 11 a
from three-phase voltage source	0.8 a per phase
10. Weight of radar components less power supplies	163 kg

Section 6. Location of Radar Components and Other Assemblies Ensuring Operation of the Radar in the Aircraft

The following units comprise the radar set in the aircraft:

1. Antenna TsD-31TP.
2. Transmitter TsD-32TK
3. Receiver TsD-33
4. Sychronization and noise-suppression unit TsD-25TK.
5. Noise interference indication unit TsD-26TK.
6. "Antenna-Ekvivalent" (antenna-equivalent) commutator unit TsD-29TPM.
7. Indicator TsD-34TPM.
8. Code- and "Verkh-Niz" marker-shaping unit TsD-36.
9. Range unit TsD-37
10. Power supply unit TsD-38.

S-E-C-R-E-T

11. Antenna control unit TsD-40TK.
12. Radar control panel TsD-41UTPM.
13. Test (monitoring) panel TsD-41KTP.
14. Connection box TsD-42 with magnetron current rheostat.
15. Magnetic amplifier and antenna tilt stabilization unit TsD-44TP.
16. Sweep unit TsD-46
17. Photographic device synchronization unit BSYu and BSYu power supply filter.
18. Camera PAU-473-1 with PAU power supply filter, light filter and focusing attachment.
19. Box of resistances for DVS.
20. Set of coaxial cables for connecting the above listed units.
21. Harness consisting of cables 19F, 19-1F, 20F, and rubber hose for air-cooling transmitter of set.

Also installed in the aircraft are units, assemblies, and components which ensure operation of the radar but which are not included in the make-up of the radar.

These include:

1. Altitude data unit VTsD-30
2. Air speed data unit DVS.
3. Signal Distributor 1186A.
4. Buttons: "Zakhvat" (lock-on), "Sbros" (break-off), "Pusk" (fire).
5. Toggle switches: "Zashcita R-2L ot zemli" (protection of R-2L against ground [noises]), "Zashchita R-2L ot passiv. pomekh" (protection of R-2L against passive-ECM).
6. Voltage converter PO-1500.
7. Voltage converter PT-500Ts.
8. Set of cables and feeders for connecting units of radar with aircraft assemblies.

Radar units TsD-32TK; TsD-33; TsD-25TK with ultrasonic delay line; TsD-26TK; TsD-29TPM; TsD-36; TsD-37; TsD-40TK; TsD-42 with magnetron current control rhoestat; and TsD-44TP are attached to the common shock-absorbing frame of the set.

The shock-absorbing frame of the radar set is in the form of a frame with special receptacles and seating areas to which the above-listed units are attached.

The shock-absorbing frame is rigidly attached to the aircraft's radar-mounting frame. The aircraft frame is in the form of two parallel channel bars with a ring rigidly attached to their forward ends and a special metal cross-beam with a center opening attached to their aft ends. The radar antenna (unit TsD-31TP) and radiotransparent cone are attached to the ring of the frame.

The aircraft's radar frame is located in the nose part of the aircraft and rests on special fixed rails. To the cross-beam of the frame is attached the rod of a hydraulic cylinder which is used to move the frame together with the radar set and cone in an axial direction.

The units mounted on the aircraft frame are connected to the remaining units of the set and to the aircraft electrical circuit by means of plug connectors Sh19F, 19-1F, Sh20F which are attached to the wall of the container. Access to these connectors is through the forward upper nose hatch.

Located in the upper nose equipment bay are units TsD-38, BSYu, BSYu filter, VTsD-30, signal distributor 1186A, and the DVS box.

The "Sbros" button is located above the left upper board of the instrument panel.

The "Zakhvat" and "Pusk" buttons are located on the aircraft control stick.

The "Zashchita R-2L ot passiv. pomekh" toggle switch is located on the left side panel.

The "Zashcita R-2L ot zemli" toggle switch is located on the left side panel.

Voltage converter PO-1500 is located behind the pilot's cockpit in the electrical power supply compartment.

S-E-C-R-E-T

Chapter Two

OPERATING PRINCIPLES IN THE BASIC MODES

(see fig. 8 in book of drawings)

The radar is operated in one of five basic modes depending upon the assigned mission of the aircraft:

1. Scanning mode;
2. Aiming mode;
3. "Locked-on beam" mode
4. Scanning-and-aiming-with-smooth-noise-interference mode;
5. Monitoring mode.

1. The Scanning Mode

When toggle switch "St. vykl. - St. vkl. - Vys. vkl." (set off - set on-high voltage on) on control panel TsD-41UTPM is placed in the position "Vys. vkl." and toggle switch "Pomekha - Soprov. - Zakr. luch" (noise - track - locked-on beam) is placed in the position "Soprov.", stabilized, rectified voltages of +300 v, +250 v, +150 v, and -250 v are connected to the radar set from unit TsD-38 and the set is converted to the target tracking mode.

Within 3 to 5 minutes after the set has been switched on, the high voltage is automatically connected. All channels of the set are synchronized by unit TsD-25TK -- the synchronization and noise-suppression unit. In order to protect the set against ground clutter created by reflections from the ground at long distances and passing through the set in the second cycle (repitition period), the radar uses wobulation (time modulation) of the repetition period of the transmitter trigger pulses with subsequent de-wobulation of the signals received from targets.

The pulses of the master blocking oscillatro 25L1 are fed to driver 4P3S, are delayed in the ultrasonic delay line, amplified in UPCh-10 (IF amplifier), and are again used to trigger the master blocking oscillator, synchronizing the latter with the frequency determined by the delay of the delay line. The pulses are sent from the master blocking oscillator to the blocking oscillator which generated the t_0 synchronizing pulses (half of tube 25L11). When operating in the aiming mode, these synchronizing pulses are sent from the output of the blocking oscillator to trigger intensity-pulse multivibrator 46L3 in unit TsD-46.

The t_0 pulses pass through wobulator 25D14, D15, delay lines 25LZ-7 through LZ-9, to the wobulated pulse blocking oscillator 25L12.

From the output of the blocking oscillator the wobulated pulses pass to unit TsD-36 and then through tubes 36L1, 2, 4 and 5 to trigger unit TsD-32TK at a frequency of T9.

When operating in the scanning mode, the submodulator shpae having a duration T_s which, through the modulator (tubes 32L1-6 through L1-7), controls the operation of the magnetron oscillator 32L2.

The RF energy from the magnetron oscillator passes through the slotted bridge, a ferrite circulator, and a double T-junction to the "Antenna-Ekvivalent" commutator TsD-29TPM. The commutoator directs this magnetron energy either into the RF end of the antenna or to the antenna equivalent.

This switiching is accomplished upon command from radar control panel TsD-41UTPM using toggle switch "ekvivlaent-izlucheniye" (equivalent-radiation). The magnetron is operated with the antenna equivalent for the purpose of radar camouflege in the event that it is unnecessary to radiate energy into space.

The pulses from block oscillator II (36L2) are fed through cathode follower I (half of 36L3) to the delay line. The delayed pulses pass through cathode follower II (half of 36L3) and trigger the receiver modulator 33L10, hlaf of L11 in unit TsD-33. The modulator generates a pulse with a duration $T_{sh.s.}$ which opens the IF amplifier of the receiver for this period of time.

The high-frequency part of antenna TsD-31TP shapes the energy applied to its primary element into a narrow beam and radiates it into space. A conical beam is formed in space when scanning motor M4 of unit TsD-31TP rotates the antenna radiator. When the radar is operating in the scanning mode, the antenna beam has the trajectory shown in Fig. 5.

As seen from this figure, the trajectory of the beam represents the result of the addition of three movements:

-- movement in an azimuthal direction to the right (left) at uniform speed;
-- elevation jumps upward (downward) at the end of the azimuthal line;
-- conical scanning.

Thus, the scanning beam of the antenna "views" the zone in space along three azimuthal lines. The radar antenna is a twin-reflector, parabolic antenna with polarization rotation. The antenna radiator is located between the reflector. In front of the radiator is a parabolic reflector.

Behind the radiator is a flat reflector which reflects the incident wave and rotates polarization. From the radiator the wave falls on the parabolic reflector. The energy formed by this reflector into a narrow beam, is reflected and falls on the surface of the flat reflector.

The flat reflector rotates the polarization of the incident wave and reflects it again in the direction of the parabolic reflector. As the flat reflector rotates, the beam moves in space. When the set is operating in the scanning mode, the flat reflector oscillates in an azimuthal direction with uniform speed and, at the end of the azimuthal line, moves upward or downward in an abrupt motion according to the pattern shown in Fig. 5. This ensures scanning of the forward hemisphere.

Motion of the antenna's flat reflector is controlled by azimuth motor M2 and elevation motor M1 of antenna TsD-31TP. The electrical coupling between antenna TsD-31Tp and ant3nna control unit TsD-40TK is provided by azimuth selsyn 31Sn3 and elevation selsyn 31Sn1, which generate voltages proportional to the position of the flat reflector of the antenna with respect to azimuth and elevation.

The voltage of azimuth selsyn 31Sn3 is fed to the azimuth search circuit 40L1 through 40L4, from the output of which an adjustment voltage is fed through azimuth magnetic amplifier 44MU1 to the control winding of the azimuth motor. Signals corresponding to the extreme azimuthal positions of the antenna reflector are fed from the azimuth search circuit to the elevation search circuit (half of 40L17, 40L5 through 40L8). At these moments the elevation search circuit begins to generate a voltage to the search circuit and the elevation "DU" (ranging unit, tubes 40L12 through 40L14), where it is added to the voltage of elevation selsyn 31Sn1.

As a result of the addition of the "jump" voltage and the elevation selsyn voltage, there appears an elevation adjustment voltage which passes through magnetic amplifier 44MU2 and controls the elevation motor 31M1.

The position of the scanned sector in space does not depend on the banking angle of the aircraft, since the antenna is stabilized in the scanning mode.

A voltage proportional to the bank angle of the aircraft passes from the aircraft's gyroscopic data unit AGD-1 through signal distributor 1186A to the stator of selsyn 31Sn6. The mismatch voltage from the rotor of selsyn 31Sn6 is fed to the input of the tilt channel (tubes 44L2 through 44L6). The adjustment voltage is taken from the output of the tilt channel, passes through magnetic amplifier 44MU3, and is fed to tilt motor 31M3 which tilts the antenna in a direction opposite the banking motion of the aircraft and by an angle equal to the banking angle. The scanned sector may be stabilized at aircraft banking angles up to $\pm 70^\circ$. To ensure the necessary transient characteristics, tach generators TG1 (elevation), TG2 (azimuth), and TG3 (tilt) are installed in the antenna control channels to provide feedback.

If targets are present in the scanned zone at ranges up to D_{ob}, the high-frequency signals reflected from the targets are received by the antenna and pass through the double T-junction, ferrite circulator, and slotted bridge to balance mixer 32D1, 32D2. The klystron oscillator voltage is also

fed to the balance mixer. The RF oscillations, converted by the balance mixer into IF oscillation, are amplified by an IF preamplifier and pass through coaxial cable F1 to the IF amplifier (33L1 through 33L6) of unit TsD-33 for main amplification. A constant intermediate frequency $f_{pr.}$ is maintained during changes in the magnetron or klyston frequency by the APChK (klystorn AFC) circuit (APChK mixer 32D3 and APChK assembly 32L4-1 through 32L4-6) in unit TsD-32TK, and is based on the compensation of any frequency deviation by an appropriate change in the voltage at the klystron reflector 32L1 which leads to a change in the frequency of the Klystron. The IF target signals from the output of the IF amplifier (33L1033L6) pass through detector 33L7. The target video pulses are amplified by video amplifier 33L8 and pass through the cathode follower (half of 33L9) and coaxial cable F5 to the video amplifier (half of 25L3) of the sychronization and noise-suppression unit TsD-25TK. The video pulses then pass from the output of the video amplifier through a pusle-duration selector (half of 25L3, 25L14, delay lines 25LZ-4, 25LZ-5, 25LZ-10) to a dewobulator (25D6, 25D7, delay lines 25LZ-1 through 25LZ-3) which restores the pulse repetition period 1/T9. When signals appear at the dewoblator which have arrived from a distance of more than 1/T9 microseconds, the pulse repetition period will not be restores by the dewobulator.

For suppression of random pulse noise, the target pulses from the dewobulator are amplified by video amplifier 25L4 and fed directly to coincidence circuit 25L5 and a delay network consisting of exciter 4P3, ultrasonic delay line, and IF amplifier-10. From the output of the amplifier the target pulses, which have been delayed by a value equal to the delay time of the line (1/T9), are fed to coincidence circuit 25L5.

Since the target pulses after dewobulation have a repetition period of 1/T9, the first delayed pulse will coincide in the coincidence circuit with the second undelayed target signal. The coincidence circuit now produces a signal which is amplified by the video amplifier (half of 25L6) and passes through cathode followers (half of 25L6 and half of 25L11) to the output of the unit.

Random noise pulses have a period differing from 1/T9; therefore, they will not coincide with their won delayed (by 1/T9) pulses in the coincidence circuit and will not pass through the circuit to the output of the unit. Signals created by ground reflections and arriving from a distance of more than 1/T9 microseconds are converted by the dewobulator into random noise and also will not pass to the output of the unit.

The output of unit TsD-25Tk will pass only target pulses whose duration at the output of the receiver does not exceed 2.5 T_s.

The integrated target pulses from the output of unit TsD-25TK are fed through coaxial cable F3 to a cathode follower (half of 36L6) whose load

50X1-HUM

[redacted]

is formed by a 12-microsecond delay line (36LZ-2 through 36LZ-4). Pulses are taken from the beginning and end of the delay line and fed to the "Verkh-Niz" (top-bottom) marker-shaping circuit (36L7 through 36L10, 36L13 through 36L17).

The elevation of a target is determined through the use of a "jump" voltage, generated by the elevation search circuit (half of 40L17, 40L5 through 40L8) of antenna control unit TsD-40TK, at the same time that the antenna is scanning space along azimuthal lines. Elevation markers appear on the screen of the indicator in the form of vertical lines above or below the target marker or simultaneously, depending upon the elevation of the target in space, on the upper, lower or middle azimuthal line respectively (see fig. 2). If the target is on the upper line of the scanned zone, target pulses taken from the end of the delay line will pass to the output of the "Verkh-Niz" marker-shaping circuit; if the target is on the lower line, target pulses taken from the beginning of the delay line will pass to the output of the circuit. If the target is on the middle line of the scanned zone, target pulses from the beginning and end of the delay line will pass to the output of the marker-shaping circuit.

Reference voltage generator 31G1 of unit TsD-31TP is used to produce "Verkh-Niz" markers in the form of several vertical marks located above or below the target marker (see fig. 2). A voltage at the scanning frequency T30 is fed from reference T30 is fed from reference voltage generator 31G1 t to a modulating pulse-shaping circuit (half of 36L13, 36L14) which doubles the frequency. The modulating pulses pass to the "Verkh-Niz" marker-shaping circuit and modulate these signals at a frequency of 2(T30) cps.

Signals from the output of the "Verkh-Niz" marker-shaping circuit are amplified by video amplifier 36L11 and are fed through a cathode follower (half of 36L12) and coaxial cable F7 to sweep unit TsD-46. The video signals pass from unit TsD-46 through a video amplifier (half of 34L2) to the cathoderay tube.

Pulses taken from approximately the center tap of the delay line are also fed to the input of video amplifier 36L11. These pulses are used to create the target markers on the indicator.

When the radar is operating in the scanning mode a "B" type sweep is formed on the screen of the indicator in azimuth and range coordinates. The "B" sweep is formed by a range sweep circuit (intensity pulse multivibrator 46L3, sawtooth voltage and current generator -- half of 46L4, 46L5) and an azimuthal sweep circuit (46D14, 46D15) in unit TsD-46. A synchronization pulse from unit TsD-25TK is used to trigger intensity pulse multivibrator 46L3.

In the scanning mode the voltage from the azimuthal sweep selsyn 31 Sn2 is fed to the azimuthal sweep circuit. The pulse from the intensity pulse multivibrator 46L3 is fed through a cathode follower (half of 46L4)

S-E-C-R-E-T

[redacted]

50X1-HUM

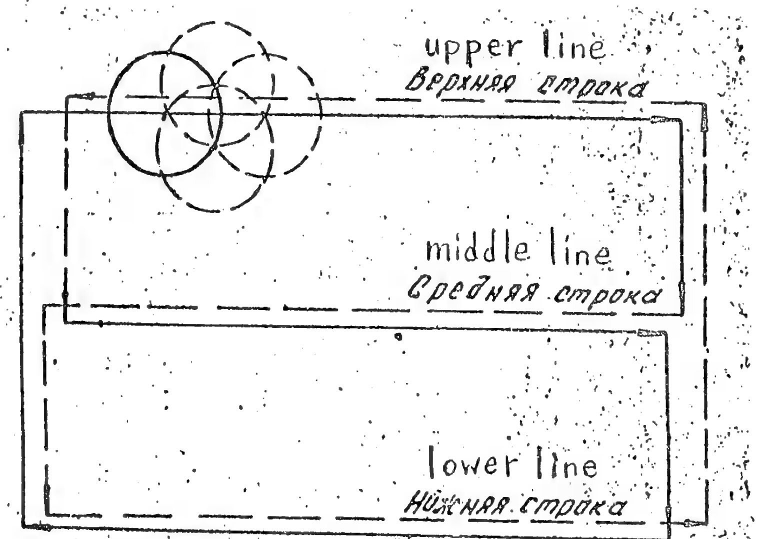
to the control electrode of the tube and opens the tube for the duration of the range sweep. The sawtooth sweep voltages are fed to the deflecting system of the cathode-ray tube of unit TsD-34TPM and create a rectangular trace on the screen of the indicator which is invisible at normal screen brightness. The target markers with the "Verkh-Niz" markers are distributed within the boundaries of this rectangular trace.

Since this set uses an intensity pulse indicator with a long-persistence tube, the persistence time is controlled by means of a special image-erasing circuit -- a pulse-erasing blocking oscillator (half of 34L2) which ensures extinction of the image in the scanning mode.

In order to provide noise-protection of the radar when operating in the scanning mode, the receiver is opened by a modulator pulse during the period following emission of the main pulse.

After emission of the main pulse, a ShARU (automatic gain stabilization) gate pulse is fed to the receiver modulator of unit TsD-33 from unit TsD-25TM. During this period the receiver is open for operation of the ShARU circuit (half of 33L11, 33L12, 33L13, half of 33L15) which automatically maintains a constant noise amplitude at the output of the receiver by changing the gain of the IF amplifier of the receiver as the noise level changes.

Note: Figure 4 not in document.



Фиг. 5 Траектория движения луча в режиме "обзор".

Figure 5. Beam Tra jectory in the "Scanning Mode"

S-E-C-R-E-T

2. Aiming Mode

The pilot presses the "Zakhvat" (lock on) button on closing with a target at a distance equal to lock-on range when there is, on the indicator screen, a target pip with the "Verkh-Niz" (top-bottom) marks located in the zero of the azimuth scale of the indicator. In this case, the set goes into "Distantsionnaya ustanovka" (DU) (ranging system) mode until the automatic range lock on is triggered. In the DU mode the antenna is positioned as to azimuth and elevation. In this mode, the pulse repetition rate of the TsD-25TK oscillator is changed and becomes equal to T19, the wobbulation of pulses which triggers the transmitter is shut off, the pulse delay of the ShARU is changed, and the TsD-32TK sub-modulator unit forms a pulse with a duration of T_{s1} which determines the duration of the high frequency pulse being radiated.

Search in azimuth and elevation by the TsD-40TK antenna control unit is switched off in the DU mode.

Voltage from the 31Sn1 elevation selsyn only, is fed to the input of the search and DU elevation circuit (40L12 through 40L14). Under the action of this voltage a mismatch in the search and DU elevation circuit turns the antenna mirror in elevation in the direction of least voltage from the 31Sn1 selsyn by means of the 44MU2 elevation magnetic amplifier and the 31M1 elevation motor. The voltage from the elevation selsyn becomes equal to zero when the antenna dish is set at an angle of + 45'.

Voltage from the azimuth selsyn 31Sn3, which is equal to zero when the antenna is in the zero azimuth position, is fed into the input of the DU and automatic azimuth tracking circuit 40L9 through 40L11. Under the action of this voltage the DU azimuth circuit 44MU forces the azimuth motor 31M2 to move the antenna mirror in the zero azimuth position. When the "Zakhvat" button is pressed a signal is sent to the TsD-37 unit for switching in the range search. In addition, the 37L13 controlling stage operates in the oscillating mode. The sawtooth voltage of the 37L13 transitron generator (slow sawtooth voltage) is compared on the 1/2 37L3 comparator with the fast sawtooth linearly decaying voltage from the phantastron 37L1; 1/2 37L2. The phantastron fast sawtooth voltage is triggered by a synchronizing pulse coming from the TsD-25TK unit. The duration of the phantastron sawtooth pulse is equal to $T_{k.p.}$ A pulse for triggering the narrow gate blocking oscillator 1/2 37L4, 37L5, is given at the moment of equality of the sawtooth voltages, which triggers the half-gate blocking oscillators 1/2 37L4, 37L6, and in the DU mode a pulse is fed through the coaxial cable F2 for gating the receiver. The delay of the narrow gate is changed from $D_{n.p.}$ to $D_{k.p.}$

[redacted]

The pulses from the half-gate blocking oscillators control the discriminator of the automatic lock on 37L14 through 37L16; 1/2 27L17, 37L10 and the tracking system discriminator 37L7 through 37L19, 37L11, 1/2 37L17. Automatic range search will be made in the DU half-gates. In the DU mode the pulse for triggering the wide gate from the TsD-36 unit is not fed into the TR-switch of the TsD-33 receiver. In this mode the receiver operates for the time of the narrow gate from the TsD-37 unit which shifts in range from $D_{n.p.}$ to $D_{k.p.}$ and the ShARU gate from the TsD-25TK unit, while the ShARU gate is supplied every cycle.

The target pulses, coinciding with the narrow gate, are fed into the input of the tracking system discriminator (37L7 through 37L9, 1/2 37L11, 1/2 37L17, 37L10. On closing with the target, the lock on of the tracking system half-gate discriminator coincides with the target at the lock on range, the range search discontinues, and the tracking system tracks the target.

A passive noise suppressor is provided in the TsD-37 range unit. Passive noise is the chaff ejected and scattered by the target-aircraft in the rear half-sphere. The closing speed of the pursuing plane with this interference is large and is close to the speed of the pursuing airplane. The signal, reflected from the chaff is either represented on the receiver output as separate (discrete) pulses or combines into one continuous pulse of long duration, depending on the frequency of chaff ejection and the speed of the target. In the latter case, the rear edge of the pulse determines the position of the target.

The method of suppressing passive noises makes it possible to lock on and track the target for range. The interval of the tracking speeds depends on the airspeed of the pursuing plane. A voltage proportional to the speed of the pursuing airplane is given off by the airspeed unit and is fed into the 1/2 37L18 speed selector circuit of the TsD-37 unit. An estimate of the closing speed is made from the moment the tracking system starts tracking the target. If the closing speed with the target exceeds the tracking speed then the 1/2 3718 speed selector and the search shift circuit (1/2 37L18, 37L19) are triggered. When the half-gates coincide with the target pulse, an estimate of the closing speed with the target will again occur. The selection continues until the target appears when pressing the lock-on button in the reverse search range and the closing speed with the target is less then the selected speed.

With the appearance of the target in the search range, the closing speed is less than the selected velocity, the range lock on automatic device (37L14 through 3716, 1/2 37L17) operates and automatically switches the set over to aiming mode. The tracking system from this moment changes over to automatic tracking for range mode, and the controlling stage (37L13) goes over to

[redacted]

integrator mode. The tracking system discriminator continuously acts through the controlling stage (37L13) on the comparator and automatically maintains a coincidence in the time of the half gates with the target pulse.

The ARU (automatic gain control) is switched in the automatic tracking mode with respect to pulse and is shielded from random noise. For controlling the operation of the ARU, two ARU half-gates, one of which coincides with the target and the other delayed relative the target, are fed through the coaxial cables F5 and F 18. The ARU circuit (1/2 33L15, 33L16 through 33L18), as a balanced circuit, reacts only on signal from the target and does not react to random pulse noise.

The range pulse from the TsD-37 unit is fed via the 1/2 33L19 limiter into the 33L20 coincidence stage. The target pulses, coinciding with the range gate, and which enter the input of the coincidence stage 33L20 through the video amplifier and the cathode repeater 33L21 by the coaxial cable F4 are fed into the antenna control unit TsD-40TK. In the aiming mode the remote antenna setting is discontinued and the TsD-40TK antenna control unit switches over into the automatic mode for tracking the target in azimuth and elevation, and antenna stabilization for tilt is also discontinued. The voltage from selsyn 31Sn5 for establishing zero setting of the antenna for tilt, through the tilt channel and the tilt magnetic amplifier 31MU3, forces the tilt motor 31M3 to fix the antenna in the zero tilt position relative the airplane.

In the aiming mode, the antenna radiator continues to rotate with a frequency T30. Since the radiator axis shifts relative to the axis of the parabolic mirror, a conical beam is formed in space with the rotation of the radiator. If the target is on the axis of the cone, then the amplitude of the signal which is received from the target depends on the instantaneous position of the antenna beam and is identical for the entire rotation period of the radiator.

If the target itself shifts relative to the axis of rotation then the amplitude of the signals received will change within specific limits reaching a maximum when the axis of the beam approaches the target (in the upper position of the directional diagram) and falling to a minimum when leaving the target (in the lower position of the diagram).

The received signals are modulated by the frequency of rotation. The spread of the changes in the amplitude of the target signal is characterized by the value of the target displacement angle relative to the equisignal direction, and the phase, relative to the direction of the target deviation.

A voltage, the so-called error signal, is formed in the 40L15 error signal detector of the TsD-40TK antenna control unit from the modulated signals from the target coming from the TsD-33 receiver output through coaxial cable F4. The error signal is used also for controlling the azimuth and elevation motors through the azimuth (40L9 through 40L11) and elevation (40L18, 40L19) tracking circuits and the corresponding magnetic amplifiers. The flat mirror of the azimuth and elevation antenna is shifted in such a way that the error signal strives towards zero. The absence of an error signal indicates an absence of modulation and in this case the target lies in the equisignal direction of the beam.

In the course of azimuth and elevation tracking of the target the flat mirror of the antenna will rotate automatically (track) following the target; i.e., the turning of the flat mirror of the antenna will correspond to the azimuth and elevation coordinates of the target. For determining the direction of the alignment inside each channel, for example, "left-right" in azimuth, a comparison is made of the rectified GON (reference voltage oscillator 31G1 of the TsD31TP unit) cascade (40L16) voltage and the signal error in each channel of the antenna control unit TsD-40TK.

The lock on and automatic tracking of the target for range and direction is indicated on the indicator screen by the appearance of "floating spot" (bird) type sweeps, the shifting of the center of which will indicate the azimuth and elevation of the target, the distance to the range marker from the center marker being the distance to the target. The darkened parts on the wings of the "bird" indicate the permissible zone for launching the missiles.

The range sweep and intensity pulse formation circuit is used for the formation of the "bird." The 46L3 intensity multivibrator in this mode is triggered by a synchronizing pulse (t_0) from the TsD-25TK unit. The range sweep circuit in the aiming mode consists of: a trigger and paraphase amplifier (46L6, 1/2 46L7), positive and negative sawtooth voltage oscillators (46L3, 46L9), and sawtooth voltage oscillator 46L10. A synchronizing pulse from the TsD-25TK unit starts the range sweep mode.

The D_{min} (46L14) and D_{max} (46L15) phantastrons are used for obtaining darkened areas on the wings of the "bird" -- the permissible firing zone. The duration of the pulses generated by the D_{max} phantastron determines the voltage U_{max}, formed by the U_{max} and U_{min} shaping circuits (1/2 37L12, 1/2 37L20, 37L21, 37L22, 37L24, 37L25) in the TsD-37 unit. The duration of pulses generated by the D_{min} phantastron is constant.

50X1-HUM

[redacted]

The U_{max} voltage depends on the closing speed with the target and the altitude of the pursuing airplane; the U_{min} voltage depends on the closing speed with the target.

Pulses from the D_{max} and D_{min} phantastrons are mixed in the 46L16 mixer, and as a result a firing zone pulse is formed at the mixer output. The firing zone pulse is mixed with the intensity pulse and on the wings of the "birds" a darkening appears, the magnitude and location of which depends on the closing speed with the target and the altitude of the flight.

When closing with the target, the dangerous closing range circuit 37L28, 37L27, 1/2 37L26 of unit TsD37, at the distance $D_{op.sb.}$ (dangerous closing range) emits a signal and the signal "O" ("Otvorot" - break off) on the TsD-34TPM indicator lights up. the break off range depends on the U_{min} voltage, i.e. on the closing speed.

The brightness and permanence of the image of the "bird" on the indicator screen in the aiming mode ensures a bright "bird" image in day and night flight conditions and an absence of persistence as the "bird" shifts across the screen. The image erase mode is changed automatically during the aiming mode by a change in the frequency of the erasing pulses from the blocking oscillator 1/2 34L2.

Movement of the "bird" in azimuth and elevation is done by the azimuthal sweep (46D14, 46D15) and elevation (46D12, 46D13) circuits. Voltages proportional to the deviation of the flat antenna mirror, are fed into the sweep circuit from the azimuth selsyn 31Sn3 and the elevation selsyn 31Sn1 of the TsD-31TP unit.

In the aiming mode, the appearance of the target in the permissible firing zone is the signal for firing the missiles, which is done by pressing the "Pusk" (fire) button on the control stick.

The pilot launches the missiles after obtaining an audible signal through his helmet phone which indicates target lock-on by the missile homing heads.

3. Locked On Beam Mode (Rezhim "Zakreplennogo Lucha")

In conditions of optical visibility with noises hindering aiming by means of the indicator screen the set is switched to the "locked-on beam" mode by setting the tumbler switch "Pomexa-Soprov.-Zakr. Luch" (noise-tracking-locked-on beam) on the TsD-41UTPM panel in the "Zakr. Luch" position.

S-E-C-R-E-T

[redacted]

50X1-HUM

[redacted]

In this mode the set operates similarly to the aiming mode with the exception of the antenna control channel which does not track the target in angular coordinates. In this (as well as in the aiming mode) the system for the stabilization of the antenna for tilt and the antenna control channel fixes the flat antenna mirror at zero azimuth and plus 45' elevation.

4. Scanning and Aiming Mode in the Case of Smooth Noise Interference

The set permits aiming in the case of a source of smoothed noise interference. Signals and noises from the TsD-33 receiver output are fed through the 1/2 33L23 cathode follower along coaxial cable F15 into the TsD-26TK unit indicating noise interference.

The appearance of smooth noise interference in the scanning mode is perceived by the set in the form of an increase in noise in the wide gate and in the ShARU gate at the receiver output. [end of page 50].

[Page 51 of the Russian text missing]

[beginning page 52]

... noise (see Fig 6)

Noises in the ShARU wide gate travel also from the receiver output into the circuit which forms the artificial target (26L10, 26L11) in the TsD-26TK unit. The artificial target pulse passing through the TsD-25TK unit enters the circuit which forms the "Verkh-Niz" mark of the TsD36 unit and then enters the indicator.

The indication of the artificial target for a distance of 8 through 12 kilometers is formed on the indicator screen independent of the distance of the source of the noise interference. The pilot, using the "Verkh-Niz" marks, moves the airplane in elevation and in azimuth, aligns the center of the marks with the zero azimuth mark, and presses the "zakhvat" button whereupon the set automatically goes to the aiming mode for the case of noise interference.

A command is given simultaneously in the TsD-40TK antenna control unit for increasing the amplification of the automatic noise tracking channel for preserving the previous modulated characteristics; in the TsD-33 unit, the auxiliary capacitance of the filter in the automatic amplification control circuit for preserving the fixed transfer characteristic, is cut out.

S-E-C-R-E-T

[redacted]

50X1-HUM

[redacted]

In the smooth noise interference mode information on the present range to the noise interference source is absent.

The set automatically goes to the target scan mode with the cessation of the noise interference.

5. Monitoring Mode

The monitoring mode is intended for rapid automatic checkout of radar operability.

The monitoring system checks the functioning of:

1. synchronizing channel,
2. radar channel,
3. range channel and passive noise suppressor,
4. break-off-attack system,
5. antenna control channel,
6. indication channel,
7. smooth interference channel.

Station checkout using the monitoring system is done visually by means of the indicator screen and the "O" (break off) and "P" (noise) signal lights located on the front of the indicator panel.

The time consumed in checking out the set by means of the built-in monitoring mode is not more than 15 seconds.

Evaluation of the operation of the set in the monitoring mode is made by means of three automatically alternating monitoring stages. Each stage has its own corresponding image on the indicator screen (see Fig 7a, b, c, d).

For changing over the set into the monitoring mode it is necessary to move the "Pomekha-Soprov.-Zakr. Luch" toggle switch of the TsD-41UTPM panel fully into the "Soprov." position, and the "Izluch.-Ekvival.-Kontrol'" toggle switch into the "Kontrol'" position. In addition, the small lamp on the TsD-41UTPM panel for monitoring high voltage on emission must be out if the set operated on emission up to the "Kontrol'" mode (i.e., in the monitoring mode the station was automatically switched over into the "Ekvivalent" operating mode).

S-E-C-R-E-T

[redacted]

50X1-HUM

[redacted]

The following picture is observed in the first monitoring stage (Fig 7a):

- the "P" ("Pomekha") lamp on the indicator burns at half intensity indicating the monitoring mode is switched on;

- the target indication appears along the entire azimuth in the scan with the elevation marks;

- the "P" ("Pomekha") signal lamp goes out which indicates the normal operation of the channel for stabilizing the antenna for tilt and the termination of the first monitoring stage.

In setting the "Pomekha - Soprov. - Zakr. Luch" toggle switch in the "Zakr. Luch" position, target lock-on in the first stage must not occur since the operating mode of the station in the presence of passive noise is imitated on this stage.

In addition, on the indicator screen a "bird" appears in the center of the range marks on the screen shifting from the edge of the sweep to the range lines and bounces from the range lines to the edge of the sweep (see Fig 7b). The first monitoring stage lasts for the time it takes the antenna to finish its tilt to the right until its cutoff, after which the command for beginning the second monitoring stage is given.

Thus, on the first monitoring stage we evaluate: the approximate sensitivity of the set, the operation of the antenna control channel (the scanning mode and the stabilization of the antenna in tilt), the shielding from passive noises (selection according to speed) with the "Pomekha - Soprov. - Zakr. Luch" toggle switch set in the "Zakr. Luch" position and the approximate adjustment of the indicator in the scanning mode.

In the second monitoring stage (Fig 7c) the "P" ("Pomekha") lamp burns at half intensity indicating the return of the antenna to its original position of tilt, corresponding to the moment the "Kontrol'" toggle switch is switched on.

The set enters the DU mode automatically, lock-on of the target occurs, a "bird" appears in the center of the indicator screen with the firing zones and the range marks, shifting "Vpravo-Vverkh" ("right-up") corresponding to the motion of the antenna up to the terminal switches.

[redacted]

50X1-HUM

[redacted]

The "O" lamp lights up signalling the operation of the dangerous-closing-range circuit.

The second monitoring stage evaluates the functioning of the antenna control channel in the DU and automatic tracking modes, the range finder with the dangerous-closing-range circuit and the approximate adjustment of the indicator scales in the aiming mode.

With the triggering of the "Pravo-Vverkh" microswitch the command for automatic switchover into the third monitoring stage is given.

In the third monitoring stage (Fig 7d) the set enters the "zakreplennyy luch" mode, as a result of which in the center of the screen a "bird" appears with the range markers, completing the search.

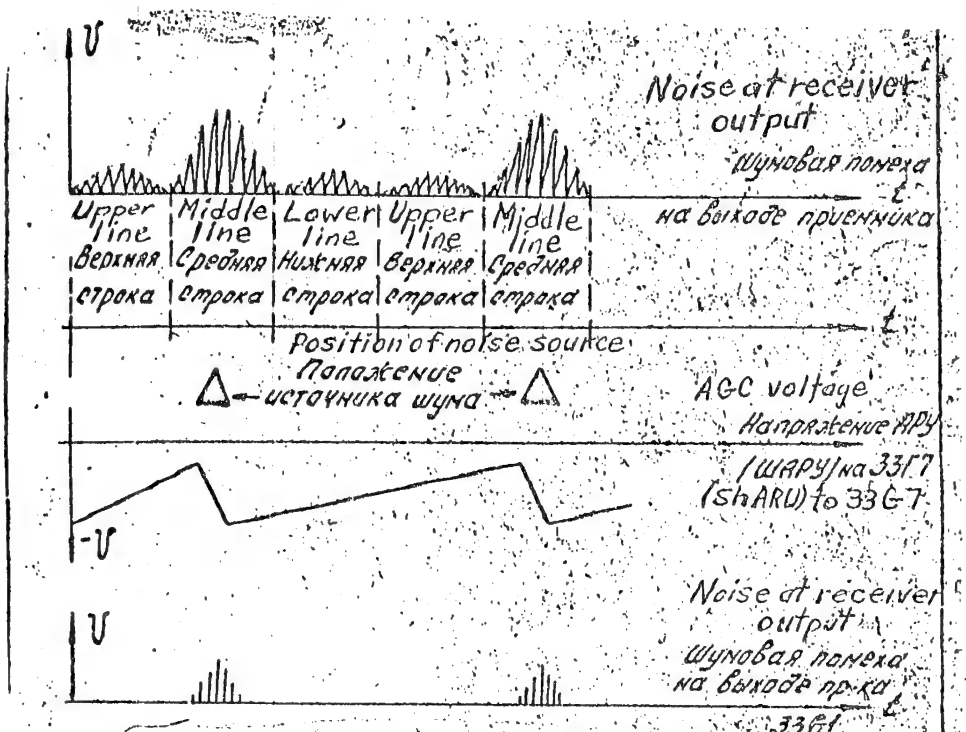
The "P" lamp burns at full intensity monitoring the circuit indicating smoothed noise interference.

The "O" lamp goes out at the onset of the third stage. Thus, in the third monitoring stage we evaluate the functioning of the antenna control channel and the rangefinder in the "zakreplennyy luch" mode. When the "Kontrol'" switch is switched off, the set returns to the scanning mode.

SECRET

[redacted]

50X1-HUM

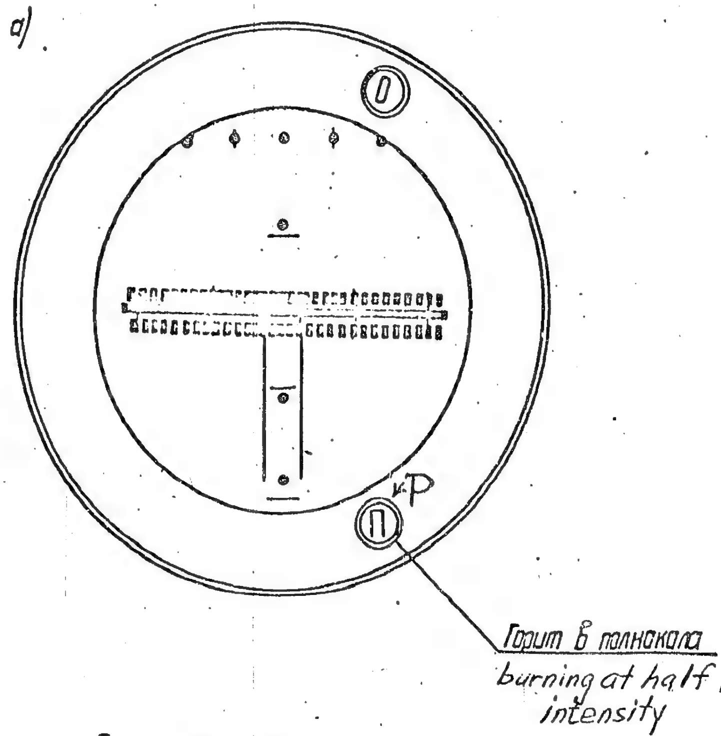


фиг. 6 . Эпюры напряжения АРУ и шумов на выходе приёмника в режиме "помэха".

Figure 6. Diagrams of AGC Voltages and Noise at Receiver Output in "Pomekha" (interference) Mode.

SECRET
СЕКРЕТНО

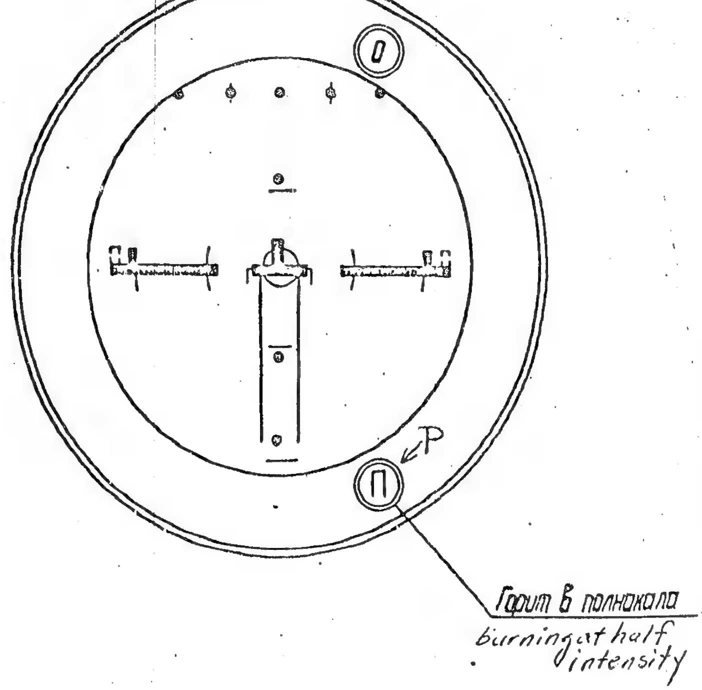
a)



I этап контроля
1st monitoring stage

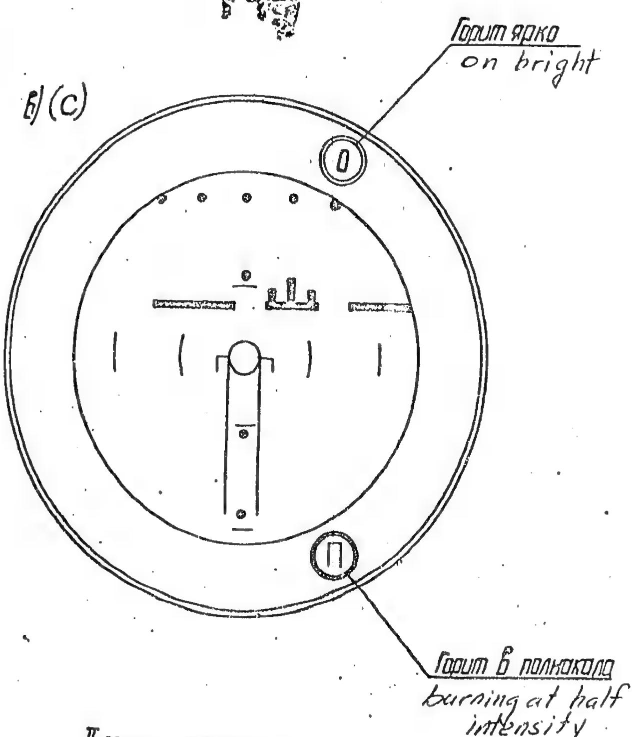
Figure 7. Indicator screen images in the monitoring mode (7a above; 7b, 7c, 7d on following pages)

б) (b)



I этап контроля при включении режима „закрепленный луч."
1st monitoring stage with "locked-on beam" mode on

S-E-C-R-E-T

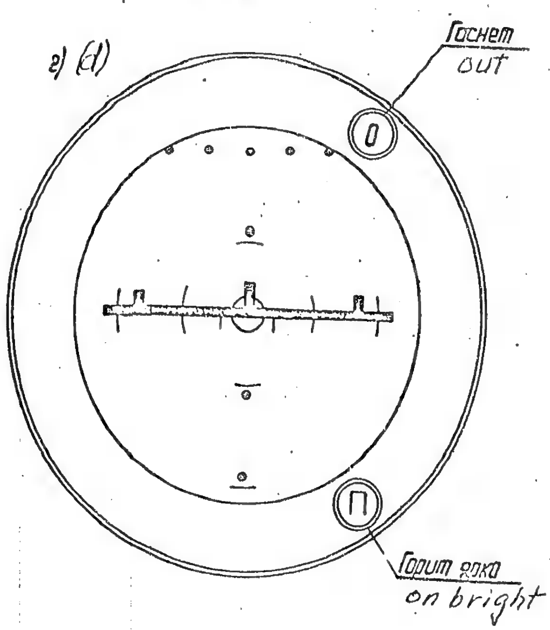


полнакала

II этап контроля
2nd monitoring stage

S-E-C-R-E-T

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3



III этап контроля
3rd monitoring stage

S-E-C-R-E-T

50X1-HUM

Chapter Three

DESCRIPTION OF UNIT INTERRELATIONS

The radar consists of a number of interconnected channels and apparatus.

The main units are:

1. Synchronizing channel
2. Radar channel
3. Suppression channel for regular (ground clutter) and random noises
4. Channel for range and suppression of passive ECM
5. Fire-control and break-off computer
6. Antenna control channel
7. Indicator channel
8. Smooth noise interference channel
9. Coupling channel with firing circuits
10. Coupling channel with altitude unit VDTs-30
11. Radar control channel
12. Radar monitoring channel
13. Radar power supply.

Interrelation of channels is shown on the radar block diagram(book, Fig 8).

Section 1. Synchronizing Channel

The synchronizing channel generates synchronizing pulses which coordinate in time the functioning of the radar channels.

Synchronizing channel components are located in the following units of the radar:

a) in the synchronizing and noise suppression unit TSD-25 TK, which synchronizes the performance of the whole radar set;

b) in the sync-pulse and "Top-Bottom" markers forming unit TSD-36, which forms triggering pulses for transmitter and receiver modulator;

c) in receiver TSD-33, which ensures gating of the receiver's amplifier;

d) in sweep unit TSD -46, which forms sweep voltage;

S-E-C-R-E-T

50X1-HUM

e) in transceiver TsD-32 TK, which forms the radar pulses;

f) in the noise interference indication unit TsD-26 TK, which forms pulses for switching the receiver to "noise" mode;

g) in junction box TsD-42, which ensures proper switching of electric circuits.

1. Forming of Sync-Pulses

Radar synchronization is ensured by the strict sequence of triggering pulses. Pulse repetition rate in the scan mode is determined by the parameters of ultrasonic delay line (UZLZ) and is equal to T9. Magnitude of the UZLZ delay depends on its designation. Pulse repetition rate in aiming mode is determined by the parameters of master blocking oscillator 25 L1 and is equal to T19.

2. Trigger-Pulse Forming for Transmitter and Receiver Modulator

To suppress second-trace echo noise originating from the reflection of main pulses from distant targets and admitted to the receiver during the second period of radar operation, wobbulation (time modulation) of transmitter trigger pulses is used. To the wobbulator input is fed sync-pulse t_0 from sync-pulse blocking-oscillator (right half of tube 25L11), which can pass through any of the two circuits: either by-passing the delay line or passing through the wobbulator delay line (25Lz-7 to 25Lz-9). Switching of the delay line is achieved by cutting-off diode D15 with the negative gradient of a special switching pulse. Wobbulator-output pulses trigger the blocking-oscillator of wobbulated pulses 25L12, which are used to trigger blocking-oscillator I (half 36L1) of unit TsD-36 and then to trigger blocking-oscillator II (36L2) and blocking-oscillator III (1/2 36L4).

When the "Zakhvat" (lock on) button on the control handle is pressed or when the operating-mode selector switch on the control panel TsD-41 UTM is set in "Zakr luch" (locked-on beam) position, relay DU (42R5-1 operates, opens contacts 4 and 3 and thus disconnects plate supply of +250 v stab. from trigger 25L9 (wobbulator and devobbulator switch). At this time trigger-pulse wobbulation is discontinued .

Pulses of blocking-oscillator III 36L4 are used to trigger transmitter TsD-32TK.

Pulses delayed by delay line 36LZ-1,5,6 are fed through cathode follower II (right half 36L3) to trigger the multivibrator receiver modulator circuit (33L10, left half of 33L11). The receiver modulator generates

S-E-C-R-E-T

pulse duration Tsh.s.(sh.s. - wide gate). In the scan mode the positive pulses from the receiver modulator are fed to the first two stages of the I-F amplifier 33L1, 33L2 of the TsD-33 unit and switch. on the receiver after transmission of a radar pulse for just the period needed for reception of reflected signals from maximum range.

In the aiming mode from unit TsD-37 to receiver modulator is fed a narrow gate pulse which coincides with the target pulse, so that the modulator turns on the receiver only for the period of target-pulse reception.

3. Forming the ShARU (Automatic Gain Stabilization) Gate.

a) In Scanning and Aiming Modes With Reflected Signals

A sync-pulse from the blocking-oscillator (right half 25L13) load triggers the delay phantastron (25L7; left half 25L3.) Phantastron pulse duration is varied (wobbulated) in the range of 25 to 75 microsec with frequency of power supply voltage from 600 to 900 cps.

Blocking-oscillator of the ShARU gate (right half L3) is triggered by the differentiated pulse corresponding to the trailing edge of the phantastron pulse.

Pulse gate of the ShARU is fed to a receiver modulator (33L10; left half 33L11) in unit TsD-33 and to ShARU gate limiter (left half 26L2) in unit TsD-26TK. Receiver modulator turns on receiver I-F amplifier for operation of the AGC circuit of the receiver with respect to set noises. Wobbulation of the ShARU trigger pulse obviates the possibility of gain regulation in receiver TsD-33 for signals reflected from distant targets arriving at the instant of ShARU operation, thus preventing any reduction in receiver amplification.

To the winding of relay 25R1 in DU is fed +27 volts, which operates the relay and increases pulse duration of the ShARU phantastron (25L7; left half 25L3). In this mode of operation the blocking-oscillator pulse period is 1/T19 and the ShARU gate pulse is formed for each cycle.

b) In the "pomekha" (noise) mode

In the "noise" mode a synchronizing pulse is fed to unit TsD-26TK to trigger the delay phantastron (26L6, right half 26L7). A differentiated pulse, corresponding to the trailing edge of the phantastron pulse triggers the ShARU wide-gate blocking-oscillator (26L9).

A ShARU wide-gate pulse is fed through a cathode follower (left half 26L7) and through closed (in "noise" mode) contacts 6 and 7 of

50X1-HUM

relay 42R20 to the receiver modulator (33L10; left half 33L11), as well as to the gate limiter (left half 26L2) of the TsD-26TK unit.

In this mode only the ShARU wide-gate pulse is fed to the receiver modulator, which turns-on the receiver for reception of noise interference.

Section 2. Radar Channel

The radar channel performs the following functions:

a) generation and radiation of radio-frequency power pulses;

b) reception and conversion of signals reflected from the target and reception of smooth noise interference;

c) switches radio-frequency power from antenna to antenna equivalent on proper command;

d) forms the directivity pattern, radiates and receives radio-frequency energy;

e) feeds target video pulses and smooth noise interference into indicator channels in the scan mode, and to the range channel and to the antenna control channel in the aiming mode.

Components of the radar channel are located in the following units:

a) in the sync-pulse and "Top-Bottom" markers forming unit TsD-36 which forms the transmitter trigger pulses;

b) in transceiver unit TsD-32TK, which generates radio-frequency pulses and converts radio-frequency pulses reflected from the target into I-F signals;

c) in the TsD-29TP unit, which switches radio-frequency energy either to antenna or to the absorbing load;

d) in antenna TsD-31TP which radiates and receives radio-frequency signals with a highly-directional beam;

e) in the receiver TsD-33, which amplifies the I-F signals and converts them into video signals.

1. Radiation of the R-F Signal

Positive-polarity pulses from cathode follower 36L5 of unit TsD-36

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

with amplitude of 40 to 60 v are admitted to amplifier 32L1-1. Positive-polarity pulses from the amplifier load are used to trigger submodulator 32L1-1.

The submodulator forms pulses of various duration in the lock-on and scan modes.

Duration of submodulator pulses is varied by changing the capacitance of the blocking-oscillator capacitor.

RF energy is admitted to waveguide with an AT/R switch, which serves to match the magnetron output with the load and prevent magnetron absorption of signals reflected from the target.

RF energy fires rhumbatron 32L3 which protects receiver crystals from overload during magnetron operation. Energy from the magnetron output, due to the presence of a slot bridge in the AT/R switch, distributes almost equally between upper and lower arms.

At the output of the device, the energy from the lower and upper arms is added up since it coincides in phase, and then it is transmitted along the waveguide through the "Antenna-Ekvivalent" switch unit TsD-29TPM) to the antenna. The antenna radiates this energy into space in the form of a highly directional beam.

Decoupling of the magnetron output with the antenna by the AT/R switch reduces the effect of the antenna load variation (during rotation of the radiator and movement of the flat reflector) on frequency fluctuation of the magnetron. This facilitates operating conditions of the APChK circuit and, therefore, reduces error during angular tracking of the target.

After completion of the radar pulse transmission, the gas-discharge tube stops firing and opens access to the mixer for signals reflected from the target.

Thus the AT/R switch and gas-discharge tube permit use of a single antenna for both transmission and reception.

The radar antenna consists of two parabolic dishes having provision for polarization rotation. An antenna of this design makes it possible to:

1) maintain steady amplification factor even at large angle of antenna dish rotation;

2) increase the rate of space scanning by increasing the angle of antenna beam deflection as compared with the angle of antenna dish deflection;

3) to form a highly directional antenna radiation pattern with relatively few side lobes.

To reduce the scan time and to reduce time for radar switching from scan mode to firing mode, space scanning is carried out with a scanning beam.

Radio-frequency energy is admitted with the aid of unit TsD-29TPM to antenna or to antenna equivalent in compliance with commands received from the control panel TsD-41UTPM of the radar.

Unit TsD-29TPM consists of the following components:

-waveguide switch with electromagnetic drive;
-antenna equivalent;
-directional coupler;
-flexible waveguide.

The waveguide switch with electromagnetic drive consists of an electromagnet whose shaft is coupled to the rotor of the waveguide switch. The rotor of the waveguide switch is in the form of an elbow (90^{o}) waveguide section. In compliance with a given command, the rotor of the waveguide switch effects coupling of the main transmitter waveguide with either the antenna waveguide or with the antenna-equivalent waveguide.

The command for switching to antenna equivalent is actuated by +27 v voltage from the aircraft network through unit TsD-42.

The command for switching-on of the antenna is actuated by +27 voltage from the control panel TsD-41UTPM. This command (when toggle switch "Izluch. - Ekvival." "Radiation - Equivalent" of unit TsD-41UTPM is set in position "Izluch") can be given only after the radar has been connected for operation. Thus, when the radar is connected for operation, the unit TsD-29TPM is automatically switched to position "Ekvivalent".

Unit TsD-29TPM has provision for blocking, which excludes the possibility of switching-on the transmitter high-voltage at intermediate positions of the waveguide switch rotor.

The antenna equivalent (absorbing load) function is to absorb radio-frequency energy and it consists of a waveguide with wedges of absorbing material placed along its walls.

Sizes and shapes of these wedges selected with a view to matching the characteristic impedance of the antenna equivalent with that of the waveguide, as well as for unifrom distribution of power along the waveguide of the antenna equivalent.

The directional coupler is in the form of two mutually perpendicular, coupled waveguides which are electrically connected to each other by two slots. The use of two slots provides an attenuation of about 30 db. The flexible waveguide connects unit TsD-29TPM with transmitter TsD-32TK which is mounted on the radar frame with shock absorbers.

The directional coupler serves to connect radar monitoring instrument RIP-1 (GK4-10).

2. Reception of Signal Reflected From the Target and Smooth Noise Interference

The signal reflected from a target is intercepted by the antenna through the waveguide track, the AT/R switch of the transmitter and then passes to crystal detectors 32D1 and 32D2 of the balanced mixer. CW from the klystron local oscillator are fed to the mixer.

As a result of mixing of radio-frequency energy reflected from the target with radio-frequency energy from the klystron local-oscillator, I-F signals are formed at the crystals which are fed to the input of the I-F preamplifier.

The I-F signals after amplification in the preamplifier are fed through coaxial cable F1 to the input of the main I-F amplifier located in unit TsD-33.

For protection of the receiver from various external noises the UPCh (I-F amplifier) operates only during the gating pulses generated by the receiver modulator.

Reception modulation is carried out in the first two stages of the UPCh (I-F amplifier). Depending on the radar mode of operation the amplifier stages conduct only:

a. during the period of wide gate and ShARU gate when operating in scan mode;

b. during the period of narrow gate and ShARU when operating in aiming mode;

c. during the period of ShARU wide gate when scanning and aiming for smooth noise interference.

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

Therefore, the noises and signals will appear at the receiver output only during the indicated gates.

3. Receiver Operation in the Scan Mode.

In the scan mode the receiver conducts noises and signals during the wide gate T_g and ShARU gate, which are formed by the receiver modulator consisting of multivibrator-selector L10 and a buffer stage using the left half of L11.

During the generation of wide gate, the stage using tube L10 performs as a driven multivibrator which is triggered by a 30 to 45-v pulse from unit TsD-36. During operation with ShARU gates the tube L10 functions as a limiter of ShARU gates, which are admitted to its input through a buffer amplifier using the left half of L11, from unit TsD-25TK through contacts 8 and 7 of relay 42P20 of unit TsD-42.

Since the amplification of the receiver in the scan mode is determined by the level of noise in the ShARU gate, provisions are made to ensure some noise immunity of the ShARU circuit.

For protection from ground pulses the ShARU gate is wobbulated by ±75 microsec, which somewhat lowers the probability of entry of ground pulses into the ShARU gate. Protection of the ShARU circuit from pulse noises is achieved with the aid of a pulse-noise limiter (left half of L15).

To prevent possible overloads of the receiver from transmitter pulses, triggering of the multivibrator-selector is delayed with respect to the transmitter triggering pulses, while the fifth stage of the I-F amplifier is cut off by positive pulse at the cathode.

4. Operation of the Receiver in the Aiming Mode

In the target-aiming mode, triggering of the multivibrator-selector by pulses from unit TsD-36 is discontinued, while narrow gate from range unit TsD-37 is fed to it. Prior to lock-on of the target by the range unit, the narrow gate moves with respect to range from Dn.p. (beginning of search) to Dk.p. (end of search).

After target lock-on, the narrow gate coincides in time with the target position.

Thus during the aiming mode the receiver operates twice: during the ShARU gate and during the narrow gate which range tracks the target.

[redacted]

To improve noise immunity of the antenna control channel during target automatic tracking, the receiver output to unit TsD-40TK is selected by the range gate which is admitted from unit TsD-37 through contacts 3 and 4 of relay 42R21 of unit TsD-42.

5. Receiver Operation With Smooth Noise Interference

When the radar is operating in the target scan mode, the appearance of smooth noise interference shows up in the form of increased amplitude of noises at the receiver output during the wide gate and ShARU gate.

The ShARU circuit does not fully eliminate increase in noise (due to the action of the pulse noise limiter). The rise of noise peaks indicates the presence of smooth noise interference(the "pomekha" lamp begins to glow on unit TsD-34TPM.) Presentation of smooth noise interference occurs in unit TsD-26TK, to which noises and signals are admitted from the receiver output. In the presence of smooth noise interference the pilot sets the toggle switch "Pomekha-Soprov. -Zakr.luch" (Noise - Tracking-Locked-on - Beam) on unit TsD-41UTPM to position "Pomekha", thus switching the radar to smooth-noise scanning mode.

In this mode only wide ShARU gate is supplied to the receiver modulator.

6. Automatic Frequency Control of Klystron (APChK).

The APChK maintains constancy of the difference between Klystron local oscillator frequency and that of the magnetron, thus ensuring stability of I-F independently of klystron or magnetron frequency deviation. Such stability of I-F ensures accurate reception of signals reflected from the target. The APChK component is located in unit TsD-32TK.

The component can operate in two modes:

a. "poisk chastoty" (frequency search) mode

b. AFC mode

a) "Frequency Search" Mode

At the instant of switching-on of the magnetron a small portion of its energy is diverted to the APChK (32D3) converter cavity, where it together with the radio-frequency energy from the klystron local-oscillator acts upon the crystal detector. As a result of this action the I-F is formed at the detector. Since the frequency of the klystron local-oscillator is being continuously changed by the saw tooth voltage admitted to the klystron reflector from the control circuit of the APChK,

S-E-C-R-E-T

[redacted]

the I-F also changes continuously.

The frequency continues to change until the I-F approaches the nominal value to which the I-F amplifier circuits are tuned.

b) AFC Mode

Negative voltage at the control grid of 32L4-5 disrupts generation of the transitron oscillator and makes it operate as a dc amplifier. Its plate voltage, which is proportional in magnitude and sign to I-F deviation from nominal value, is fed through cathode follower 32L4-6 to the klystron reflector and changes its frequency until the I-F becomes equal to its nominal value.

If the I-F for some reason deviates out of the control range, then the transitron oscillator will again begin to generate the saw tooth voltage, i.e., the APChK circuit will return to the search mode.

c) Manual Frequency Control of Klystron

When the radar operates with disconnected high voltage, the APChK circuit performs the frequency search, while the noise at the receiver output of unit TsD-33 varies with the frequency of search.

For radar operation with disconnected high voltage and with connected ground control panel TsD-48, provisions are made for manual frequency control of the klystron.

When the toggle switch "RRChK - APChK" (Klystron Manual FC - Klystron AFC) on unit TsD-48 is set in position "RRChK" then +27 voltage is fed to relay 32 R4-1 of unit TsD-32TK. Now relay 32R4-1 operates and disconnects the input of cathode follower 32L4-6 from the transitron oscillator. At this time negative voltage from panel TsD-48, which is controlled by potentiometer "Napr.RRChK" ("Voltage Manual AFC"), is fed to cathode follower input (32L4-6).

A change in this voltage also changes the negative voltage at the klystron reflector, thus changing its frequency.

Section 3. The Second-Trace Echo and Random Pulse Noise Suppression Circuit.

The noise suppression channel ensures proper radar performance in presence of reflections from ground during distant scanning, the random and second-trace echo pulse noises arriving during the second period of radar operation.

S-E-C-R-E-T

Components of the noise suppression channel are located in the following units:

a. in the synchronizing and noise suppression unit TsD-25TK,

b. in receiver TsD-33,

c. in the junction box TsD-42, which provides proper switching of the noise suppression circuits.

1. Suppression of Pulses Reflected from Ground and Arriving During The First Cycle of Radar Operation.

Due to the great reflecting surface, the pulse reflected from the ground and received by radar during the first cycle of operation has a considerable duration. Suppression of such ground pulses is achieved by a gating circuit which selects on the basis of pulse duration. This circuit consists of:

a) limiter (left half 25L3),

b) delay line 25LZ-4,

c) delay line 25LZ-5, 25LZ-10 and video amplifier (right half 25L3,)

d) pulse-width discriminator 25L14.

Video pulse from target and pulses reflected from ground are fed from receiver TsD-33 output through high-frequency cable F5 to unit TsD-25TK. Limiter (left half 25L3) serves as an input in unit TsD-25TK, while the delay line LZ-4, shorted at the end, serves as a load to the limiter.

At the output of this delay line appear two pulses of equal duration, but opposite in polarity and delayed with respect to each other. The magnitude of such a delay is determined by the pulse duration at the limiter input.

The positive pulse of the two is admitted directly to the pulse-width discriminator circuit 25L14, while the negative pulse is delayed in delay line LZ-5 and LZ-10 and then is admitted to the video amplifier (right half 25L3). Positive pulse from the video amplifier output is also admitted to the pulse-width discriminator. The pulse-width discriminator will permit passage of signals only if pulses from the limiter output (left half 25L3) and from the video amplifier (right half 25L3) coincide at its input.

Thus the pulses reflected from the ground and arriving during the first cycle of radar operation will not pass through the pulse discriminator circuit to unit TsD-25TK due to their greater width. (duration).

2. Radar Protection From Random Pulse Noise

Protection from random pulse noise is achieved by a special suppressor circuit in unit TsD-25TK, which consists of:

a) a coincidence circuit 25L5 which passes video signals only in case of coincidence of non-delayed and delayed pulses, the latter delayed by the repetition period of the target video signals;

b) a delay circuit which provides video-pulse delay for a period (cycle) of radar repetition;

c) integrating circuit which amplifies signal amplitude.

The random pulse noises, the period of repetition of which differs from the radar pulse repetition rate, will not coincide in time on the grids of the coincidence stage and therefore will not be admitted to the output of the unit. Probability of coincidence of random pulses is low due to their irregular appearance.

3. Suppression of Ground Clutter Arriving During the Second Period of Radar Operation

Unit TsD-25TK has provision for suppression of ground clutter having the repetition period of the radar 1/T9 µsec and arriving during the second cycle of radar operation. Due to great reflecting surface of the ground, these signals may have sufficient intensity at the receiver output to form spurious target marks on the indicator.

To protect the radar from such ground clutter noises, wobbulation (modulation in time) of radar pulses is utilized. To ensure proper performance of the suppression system during the first period (cycle) of radar operation, dewobbulation of signals reflected from the target is used.

4. Suppression of Noises Arriving During the Time of Receiver Operation Actuated by Pulses From ShARU

To prevent passage of pulse noises or pulses reflected from distant targets, at the receiver output, during the period of its operation by ShARU pulses, the ShARU pulses are wobbulated (modulation of pulse repetition period).

Wobbulated ShARU pulses are formed in unit TsD-25TK by a circuit consisting of:

a) delay phantastron 25L7 and left half 25L8;

b) blocking-oscillator of ShARU pulses (right half 25L8);

c) cathode follower left half 25L13.

The sync pulses from the blocking-oscillator output (right half 25L-13) trigger the delay phantastron 25L7, which forms pulses in the scan and aiming modes. Change in the duration of phantastron pulses is achieved by switching contacts 3, 4 and 5 of relay 25R1. The blocking-oscillator of ShARU pulses (right half 25L8) is triggered by the differentiated trailing edge of the phantastron pulse.

In addition, the receiver is protected from random noises by a pulse-noise limiter (left half 33L15) which, in the "noise" mode is disconnected by relay 33R2. To prevent upsetting of synchronization in unit TsD-25TK by pulse noises arriving in the zone of ShARU noises, the ShARU pulses from the blocking-oscillator (right half 25L8) output are fed to pulse-width discriminator 25L14 and block it for the period of ShARU operation.

Thus turning on of the receiver and gating of the ShARU circuit by wobbulated pulses ensures suppression of noises in the ShARU gate.

In addition to wobbulation of ShARU pulses, there is provision for detuning of the klystron oscillator of unit TsD-32TU for the period of ShARU action.

5. Protection of AGC System of Receiver I-F Amplifier From Random and Irregular Noises

Noise immunity of the AGC system of the receiver I-F amplifier is achieved by time discriminator and balanced detector.

Two coincidence stages(33L17 and 33L18) are used as the time discriminator.

When present, the noise will coincide with the first or second gates of the AGC in the coincidence stages. The generated pulse signals are detected by the diodes of the difference detector 33L16 and are subtracted on the common load. Therefore the resulting voltage is almost zero, so that the noise effect on target-pulse amplification in the receiver is insignificant.

The AGC system of the receiver I-F amplifier operates only during the tracking mode.

6. Protection of Antenna Control Channel From Noise

To ensure noise immunity of the antenna control channel during automatic target tracking in unit TsD-33, range gating for target signals is used on unit TsD-40TK, in addition to narrow-gate discrimination in the receiver. At the coincidence of the range gate with the target, pulses from the coincidence stage output are taken in this gate and are fed through video amplifier and cathode follower 33L21 to the antenna control unit TsD-40TK.

Section 4. The Range and Passive ECM Suppression Channel

This channel performs the following functions:

a) supplies the receiver TsD-33 with narrow gate;

b) performs automatic search and selection of locked-on target on the basis of rate of closing with it, while in target delay range from Tk.p. to Tk.s.

c) locking-on and automatic range tracking of target in the delay range of Tk.p.to Tk.s..

d) protects the range measuring part of the channel from the effect of passive noise caused by dipole chaff dropped by the target aircraft;

e) automatically determines the present range to target during target tracking;

f) supplies range pulses with amplitude of 30 ± 5 v for gating the antenna control channel input and for forming of the range markers in the indicator;

g) supplies "gate ARU-1" and "gate ARU-2" (pulses with amplitude of 60 to 100 v) to the protection circuit of the AGC of the receiver.

The elements of the channel are located in the following units of the radar:

- in the range unit TsD-37,
- in the synchronization and suppression unit TsD-25TK,
- in the receiver unit TsD-33,
- in the sweep unit TsD-46,
- in the indicator unit TsD-34TPM,
- in the DVS instrument.

Electrical connection of units is achieved through unit TsD-42.

The whole channel consists of:

a) automatic tracking system;

b) lock-on automatic device,

c) circuit for protection of range meter from the action of passive noise.

The principal circuit here is the automatic tracking system, which conducts automatic search and automatic range tracking of the target. The other two systems are subsidiary to the first one, and each one performs its specific function.

1. The Automatic Tracking System

The automatic tracking system begins its search for the range to the target after the button marked "Zakhvat" (lock-on) on the aircraft's control stick has been pressed. At this moment control stage 37L13 (right half of tube 37L12), whose screen grid was previously blocked, switches to an oscillating mode, representing a transitron oscillator, and generates a linearly dropping voltage ("slow saw-tooth").

The linearly dropping saw-tooth voltage passes from the control stage through a distributing diode (half of L20) to a comparator (left half of 37L3) where it is compared with the linearly dropping saw-tooth voltage ("fast saw-tooth") of phantastron 37L1 (left half of 37L2). The phantastron is triggered by pulses from unit TsD-25TK and generates a linearly dropping saw-tooth voltage having a duration of [numbers missing]. The comparator is based on the left half of tube 37L3 and establishes the moment of equality of the absolute values of voltages from the phantastron and the control stage; at this moment the comparator generates a negative pulse which triggers the gate blocking oscillator (left half of 37L4, 37L5). The narrow-gate blocking oscillator shapes a pulse which gates the receiver in the DU and aiming modes. This same pulse triggers the half-gate blocking oscillator (right half of 37L4, left half of 37L6) which is used to shape the "range gate" pulses. One pair of half-gate pulses passes to the coincidence stages of the tracking system (tubes 37L7, 37L8), and the other pair passes to the coincidence stages of the automatic lock-on system (tubes 37L14, 37L15). When target video pulses appear and coincide with the half-gate pulses, the tracking system switches to the target tracking mode.

If target pulses are absent, automatic search takes place.

In order to produce a visual display of range to the target, the range and passive-ECM protection channel generates a range pulse taken from the load of a cathode follower (half of 37L26). Then the range pulse is shaped by the indicator into a range marker located on the artificial target display (the "bird").

2. The Automatic Lock-On Device

The automatic lock-on device records the moment of target lock-on and transition of the automatic tracking system from the search mode to the automatic tracking mode.

The automatic lock-on device of the range and passive-ECM protection channel consists of:

a) coincidence stage I (37L14), coincidence stage II (37L15), difference detector 37L16, and discriminator;

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

b) amplifier (half of 37L17);

c) electromechanical relay R1, R2 (37L10).

Current passing through relays R1 and R2 causes the relays to trigger and converts the set from the scanning mode to the aiming mode, as a result of which:

a) voltage from the search direction commutator is cut off from the cathode follower of the tracking system discriminator in the range and passive-ECM protection channel;

b) the "memory" (capacitor) element is connected to the detector of the tracking system discriminator, providing storage of the closing speed with the target during automatic tracking;

c) connects the capacitor to the tube grid of the electromechanical relay in the automatic lock-on device, delaying release of the automatic lock-on device in the event that the target signal disappears;

d) connects the windings of doubling relays 42R6 and 42R6-1 to ground;

e) energizes the circuit which signals dangerous closing range;

f) connects range voltage to the U_{min} and U_{max} voltage-shaping circuit;

g) disconnects the search limiter;

h) disconnects power supply from the search shift stage of the passive-ECM protection circuit.

3. Circuit for Protecting the Radar Against the Action of Passive Interference (Passive-ECM)

The following stages provide protection of the radar against the action of passive-ECM:

a) coincidence pulse amplifier of coincidence stage II of the tracking system discriminator (left half of 37L11);

b) speed selector (left half of 37L18);

c) blocking stage of the automatic lock-on device (right half of 37L19);

d) search shift stage (left half of 37L19);

50X1-HUM

e) multivibrator R5 (37L29, 37L30);

f) stage for disconnecting search shift (right half of L18).

When the target aircraft switches on its device for creating passive interference, bundles of dipole reflectors are ejected from the aircraft into the rear hemisphere and disperse once they have separated from the aircraft. The main pulse from the radar transmitter is reflected from these bundles of dipole reflectors. Thus, these pulses reach the receiver input along with the pulses reflected from the target. Depending upon the rate of ejection of the dipoles from the aircraft, the noise may have the character of either discrete pulses or a "chaff cloud".

The effect of passive-ECM on an unprotected radar set reduces to the situation where, as the interceptor approaches the chaff-dispersing aircraft, the active zone of the intercept radar first "sees" the noise pulses, which are closer to the interceptor than the target pulses and cause triggering of the automatic range lock-on device. The radar begins to track the noise pulse while the target is lost and use of the radar becomes impossible.

If the target aircraft is being tracked and it begins to eject bundles of dipole reflectors, then as a result of the fact that the reflectors disperse immediately after separation from the aircraft and, consequently, the target pulse and the noise pulse which has just separated from the target are indistinguishable with respect to their range, the automatic tracking system "locks on" the noise pulse and is led away from the target toward the noise. As a result the target is lost.

A circuit for protection against passive ECM must perform the following functions:

1) analyze the closing speed of the locked-on pulse; continue the search and unlock from this pulse;

2) provide stable tracking of a target which disperses chaff;

3) permit range determination to a target in the presence of "chaff clouds". 50X1-HUM

1. Unlocking from the noise pulse and continuing the search is achieved through the use of a speed selector (left half of tube 37L18) which the pilot activates with the toggle switch marked "Zashchita R-2L ot passiv. pomekh" (protection of R-2L against passive ECM).

The closing speed of the interceptor with the dipole reflectors at the applied angles of attack is significantly greater than the closing speed with the target and is close to the flight speed of the interceptor.

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

The system operates as follows: the automatic range tracking system "locks on" the noise pulse and begins to track it. The negative voltage from the cathode follower (left half of 37L17) of the tracking system discriminator, representing the closing speed with the noise, passes to the input of the speed selector. At the same time, a positive speed voltage passes to the input of the speed selector from the air speed data unit (DVS).

This voltage is introduced for the purpose of expanding the range of tracking speeds, that is, as the flight speed of the interceptor increases, the speed required for tracking also increases.

The total voltage closes the normally open tube of the speed selector (left half of 37L18), and the voltage at the output of the selector increases and unblocks the tube of the stage which blocks the automatic lock-on device (right half of 37L19) and the tube in the search shift stage (left half of 37L19).

Simultaneously with blocking of the automatic lock-on stage, the tube of the search shift stage opens and triggers relay R3. The relay then connects capacitors 37C49, 37C50, which have been charged preliminarily by part of the range voltage, between the grid and the plate of tube 37L13 in the control stage, with the positive side to the grid. As a result, the range voltage drops sharply and the gating pulse and half-gates "rebound" in the direction of greater range.

In order to facilitate ground checking of the speed selector, the channel incorporates a DVS voltage simulator which is connected by the signal "Shassi vypushcheno" (wheels down). It is then possible to simulate the flight speed of the interceptor.

2. Stable tracking of a target which has ejected dipole reflectors is achieved by the introduction of an imbalance into the discriminator of the automatic tracking system and the introduction of a balanced AGC circuit in the receiver.

Imbalance of the discriminator is achieved by the pulse amplifier of the second coincidence stage, the tracking system discriminator (half of 37L11).

The presence of a dealyed gate pulse (IF amplifier gate) relative to the target pulse leads to the situation where only a minor part of the noise pulse passes through the receiver's IF amplifier, which provides additional protection against passive interference.

3. Search for the target under "chaff cloud" conditions is achieved as a result of inbalance of the discriminator of the automatic range tracking system and the use of a balanced discriminator at the input of the automatic lock-on circuit.

50X1-HUM

[redacted]

When the "range gate" coincides with the "chaff cloud," imbalance of the tracking system discriminator causes the "range gate" to begin shifting toward the trailing edge of the pulse and, in this manner, the "range gate" moves within the "chaff cloud." When the "range gates" reach the trailing edge of the pulse, which corresponds to the position of the target, the automatic lock-on triggers and begins to track the target.

Section 5. The Fire Control and Break-Off Computer

When the fire control and break-off computer is in the automatic range tracking mode (aiming mode) it forms on the artificial target display -- the "bird" -- a zone of firing, and when the interceptor has approached the target to a range of $D_{opt.}$ firing and closer, it signals the pilot of a dangerous closing range.

Components of the computer are located in the following units of the radar:

-- In range unit TsD-37;

-- in synchronization unit TsD-25TK;

-- in receiver TsD-33;

-- in sweep unit TsD-46;

-- in indicator TsD-34TPM;

-- in unit VTsD-30.

Electrical connections between the units are provided by unit TsD-42.

1. The Fire Control Computer

The firing range depends on the closing speed of the interceptor with the target and the flight altitude.

The permissible firing zone is limited by two ranges -- the minimum range D_{min} and the maximum range D_{max}. The maximum firing range depends on the closing speed of the interceptor with the target and the flight altitude, while the minimum firing range is constant.

The firing zone is portrayed on the artificial target display (the "bird") by impressing the negative zone pulse, produced by mixing the two positive square pulses of the phantastrons -- the D_{min} phantastron and the D_{max} phantastron of unit TsD-46, on the positive "bird" intensity pulse.

S-E-C-R-E-T

[redacted]

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

50X1-HUM

The minimum and maximum limits of the firing zone are proportional to the duration of the phantastron pulses D_{min} and D_{max}, respectively. The duration of the phantastron pulse D_{max}, in turn, is controlled by the constant coltage U_{max}. This voltage is generated by a special circuit located in unit TsD-37. Voltage U_{max} is proportional to the closing speed and the flight altitude.

Thus, the minimum limit of the firing zone produced by phantastron pulse D_{min} is constant.

The maximum limit of the firing zone produced by phantastron pulse D_{max} is proportional to voltage U_{max} and, consequently, is proportional to the closing speed and flight altitude.

Voltage U_{max} is the sum of three voltages:

a) voltage U(H), which is proportional to the flight altitude of the interceptor;

b) the constant zero-speed voltage;

c) a voltage proportional to the closing speed.

The variable voltage from the altitude data unit VTsD-30, which is proportional to the flight altitude, passes to one of the outputs of the altitude voltage rectifier (half of 37L20).

The D_{min} and D_{max} phantastrons of unit TsD-46 are triggered by synchronization pulses from unit TsD-25TK and generate positive square pulses.

The positive pulses of the phantastrons are mixed in a mixer tube (half of 46L16). The plate load of the mixer produces a positive square zone pulse whose leading and trailing edges coincide in time with, respectively, the trailing edges of the D_{min} and D_{max} phantastron pulses.

This positive pulse is amplified by a video amplifier (half of 46L16) and its phase is shifted 180°.

As it passes through the cathode follower (half of 46L4), the positive zone pulse is mixed at the common load of the mixer and the intensity multivibrator (46L3), and the negative zone pulse is mixed with the positive "bird" intensity pulse.

Hence, in the presence of a zone pulse the "bird" is not illuminated and dark segments -- the "firing zone" -- are formed at the "wings" of the "bird."

50X1-HUM

2. Device for Signalling Dangerous Closing Range

The signal indicating a dangerous closing range is dispalyed on the "O" ("Otvorot" - break-off) display, located above the indicator screen, when the closing interceptor reaches the danger range to the target aircraft.

The zone of dangerous closing range, which is in the form of a positive square pulse, is generated by a phantastron based on tube 37L28 in a circuit with cathode coupling. The phantastron is triggered by synchronization pulses from unit TsD-25TK.

The duration of the phantastron pulse is determined by the value of the plate voltage set by the "Komanda" (command) potentiometer (37P198), which is connected in the +250-volt (stab.) voltage divider network and depends on the value of voltage U_{min}. Voltage U_{min} is generated by the U_{min} and U_{max} voltage-shaping circuit and depends on the closing speed with the target. At an altitude of 14 km the voltage at the plate of the phantastron increases suddenly, which means that the duration of the pulse generated by the phantastron also increases.

When the half-gate pulse coincides with the phantastron pulse, the comparator generates a negative voltage which closes the normally open tube (half of 37L27) of the d-c voltage amplifier. The voltage at its plate increases and the voltage at the input of the electromechanical relay increases from -30 volts to zero. Electromechanical relay R4 (half of 37L26) triggers and connects the +27-volt supply to the lamp in the "Otvorot" display located above the screen of indicator TsD-34TPM.

Section 6. The Antenna Control Channel

The antenna control channel provides for:

a) control of the antenna in the scanning mode;

b) setting the antenna in the "DU" and "Zakreplennyy luch" modes;

c) automatic angle tracking of a locked-on target;

d) automatic angle tracking of a source of smooth noise interference;

e) sending voltages from the azimuth and elevation selsyns to the indicator channel of the radar for the purpose of synchronizing the indicator sweeps with the position of the radar beam in space;

f) stabilization of the tilt position of the antenna until transfer to the aiming mode;

[redacted]

g) disengagement of tilt stabilization upon transfer to the aiming mode.

Elements of the antenna control channel are located in the following units of the radar:

a) in antenna control unit TsD-40IK, which forms the control voltages giving motion to the antenna in the azimuthal and elevation directions;

b) in unit TsD-37, which generates a "ground" voltage through the "Sbros" (break off) button to automatic lock-on relays 42R6, 42R6-1 of unit TsD-42 after range lock-on of the target;

c) in the magnetic amplifier and tilt stabilization unit TsD-44TP, which amplifies and converts the signals from unit TsD-40IK into voltages which control the operation of the azimuth and elevation motors of unit TsD-31TP. Unit TsD-44TP also provides tilt stabilization of the antenna and disengages tilt stabilization upon transfer to the aiming mode;

d) in antenna unit TsD-31TP, which provides motion of the scanning beam and generates voltages for antenna control unit TsD-40IK for the indicator channel and unit TsD-44TP.

e) in receiver TsD-33, which provides a gated target pulse to antenna control unit TsD-40IK;

f) in junction box TsD-42, which ensures commutation of the networks of the antenna automatic control device;

g) in the radar control panel TsD-41UTPM, which provides for switching of the operating modes of the radar.

1. Space Scanning

In the scanning mode the antenna control system provides for swinging of the flat reflector of the antenna in the azimuthal direction and for step-like changes of the reflector in elevation.

At those moments when the flat reflector of the antenna passes through the outermost points of the azimuthal line, the phase of the voltage taken from selsyn 31Sn3 changes by 180° (see Fig. 9) and, in one half of phase detector tube 40L2, is in opposition to the reference voltage applied to this half of the tube. This half of the tube opens briefly under the influence of the positive half-wave of the reference voltage, causing a reversal of flip-flop 40L3 and a change in sign of the current imbalance in the IF amplifier (tube 40L4).

[redacted]

[redacted]

The appearance at the input of the search circuit and DU (with respect to elevation) of voltage "jumps" having one or another phase corresponds to a jump of the antenna reflector correspondingly to the upper or lower line, while the absence of a "jump" corresponds to movement of the antenna to the middle. line.

Thus, the phase of the voltage "jumps" determines the direction of movement of the reflector with respect to elevation (upward or downward) relative to the middle line. The action of the voltage from selsyn 31Sn1 returns the antenna reflector to the middle line.

In order to protect the radar against "ground" pulses during flights at low altitudes, the bottom line is deactivated. Voltage "jumps" with a deactivated bottom line are shown in Fig. 10.

The trajectory of the beam will be as shown in Fig. 11.

The pilot may deactivate the bottom line by placing the toggle switch marked "Zashchita R-2L ot zemli" (protection of R-2L against ground), which is located in the cockpit, in the position "men'she" (less).

A "ground" voltage passes from the toggle switch in unit TsD-40TK to the winding of relay 40R5. The relay triggers and interrupts the circuit which supplies a single reference voltage to modulator tube 40L8; the phase of the voltage determines movement of the flat reflector of the antenna from the middle line to the bottom line.

2. Remote Setting of the Antenna

When the "Zakhvat" button on the control stick is pressed, the continuous searching movement of the flat reflector ceases.

The radar is converted to the intermediate mode "DU" with the antenna set in a zero position with respect to azimuth and at +45' elevation.

3. Locked-on Beam

In order to convert the radar to the locked-on beam mode, the operating mode switch on control panel TsD-41UTPM is placed in the position "Zakr. luch" (locked-on beam). This disconnects the "ground" from the windings of relays 42R16, 40R1 and 40R2 and connects it to the winding of relay 42R6. Relay 42R6 triggers and sends +27 volts through contacts 4, 5 to the windings of DU relays 42R5, 42R5-1, 42R5-2, and 40R3. The latter relays convert the radar to the "DU" mode without the possibility of coordinate tracking of a target after range lock-on.

S-E-C-R-E-T

[redacted]

[redacted]

4. Automatic Target Tracking

The automatic target angle tracking mode begins upon triggering of the automatic range lock-on circuit of unit TsD-37, from which a "ground" pulse passes through the "Sbros" button to the winding of relay 42R6.

The amplitude-modulated video pulses of the target pass from the output of receiver TsD-33 through coaxial plug F4 to the input of the error-signal separation circuit (tube 40L15) of antenna control unit TsD-40TK.

The target pulses are modulated by the scanning beam as a result of a deflection of the target from the equisignal direction of the antenna; this deflection is formed by rotation (scanning) of the radiator, whose axis is displaced relative to the focal axis of the antenna reflector. Since the antenna control system represents a closed servo system containing inertial elements, oscillatory processes may originate within it. The system is damped by the incorporation of negative feedback in the channel which is provided by the azimuth tach generator 31TG2 and the elevation tach generator 31TG1.

The voltage from the tach generators, which is dependent upon the speed of movement of the antenna's flat reflector in the corresponding plane, is fed to the feedback windings of the azimuth and elevation magnetic amplifiers. Now the voltage at the output of the magnetic amplifier in the appropriate channel, which causes an accelerated movement of the antenna reflector, drops, movement of the flat reflector of the antenna is retarded, and the system is damped.

5. Tracking a Source of Smooth Noise Interference

When smooth noise interference is present the operating mode switch of unit TsD-41UTPM is placed in the position "Pomekha" (noise). The radar converts to a noise interference scanning mode. An artificial target echo with the markers "Verkh-Niz" (top-bottom) appears on the screen of indicator TsD-34TPM. When the "Zakhvat" button is pressed the reflector of unit TsD-31TP is set in the zero azimuth position, after which unit TsD-26TK generates a command which converts the radar to the noise source tracking mode. The gain of unit TsD-40TK is increased in this mode.

The increase in gain of unit TsD-40TK in the noise interference tracking mode is caused by the fact that antenna TsD-31TP, when operating in this mode, receives only noise interference. Therefore, the reduction in gain of the servo system due to the fact that the antenna is not transmitting is artificially compensated by the increase in gain of the antenna control units TsD-40TK.

[redacted]

6. Tilt Stabilization

The tilt channel includes:

-- the antenna tilt control circuit, located in unit TsD-44TP (tubes 44L2 through 44L6);

-- the tilt magnetic amplifier 44MU3;

-- the tilt motor 31M3;

-- the tilt tach generator 31TG3;

-- the antenna tilt stabilization selsyn 31Sn6;

-- the selsyn for returning the antenna to "zero" tilt 31Sn5.

When the radar is operating in the scanning and "DU" modes (before range lock-on of the target), the position of the antenna with respect to tilt is stabilized. Tilt stabilization occurs as follows:

The tilt signal sent to antenna unit TsD-31TP is generated by the gyroscopic data unit of the remote gyro-horizon AGD-1 and passes through signal distributor 1186A, which is a power signal repeater for the tilt signals.

Signal distributor 1186A is designed for the simultaneous generation of signals having equal or identical characteristics to several systems of the aircraft.

Tilt angles are transmitted by a servo system which includes:

-- transmitting selsyn of gyroscopic data unit AGD-1;

-- receiving selsyn;

-- tilt generating circuit;

-- transmitting selsyn of signal distributor 1186A;

-- receiving selsyn 31Sn6 of antenna unit TsD-31TP.

If the aircraft goes into a banking movement there occurs a mismatch between the gyro data unit transmitting selsyn and the signal distributor receiving selsyn.

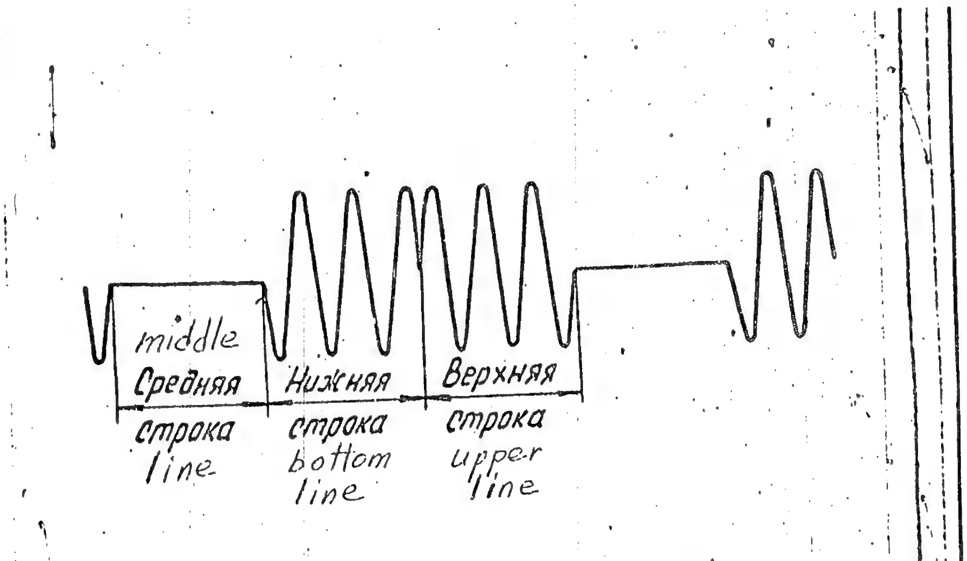
At the output of the magnetic amplifier there will appear a voltage which controls tilt motor 31M3, turning the antenna tilt platform until the signal at the input of amplifier 44L2 equals zero. The

antenna tilt platform turns in a direction opposite the banking direction of the aircraft, offsetting the latter. When switching to the aiming mode, relay 44R4 triggers, disconnects the rotor of selsyn 31Sn6 from the input of amplifier 44U2, and connects the third phase of the stator of selsyn 31Sn5 which returns the antenna to zero tilt.

As a result of the action of the voltage from selsyn 31Sn5, whose zero value coincides with the zero on the tilt scale, the antenna returns to zero tilt and is held in this position for the duration of operation in the aiming mode.

S-E-C-R-E-T

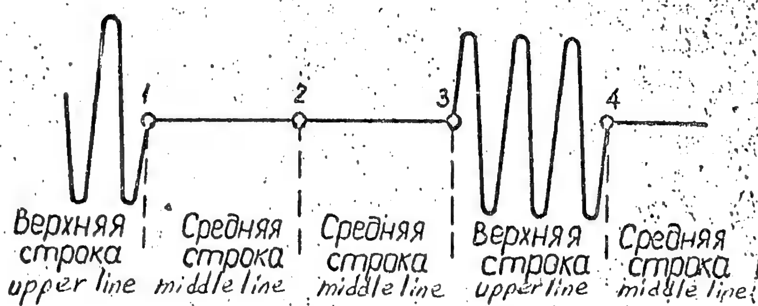
Note: Figure 8 not in document.



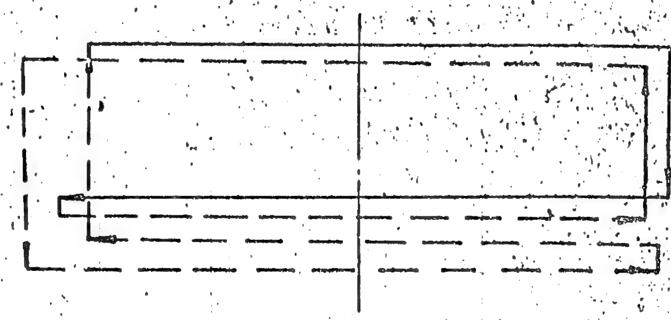
Фиг. 9. Напряжение "скачков"

Figure 9. Voltage of "Jumps"

S-E-C-R-E-T



Фиг.10 Напряжение "скачков" при отключенной нижней строке.



Фиг.11 Траектория движения луча при отключенной нижней строке.

Figure 10. Voltage of "Jumps" With Bottom Line Out

Figure 11. Beam Trajectory With Bottom Line Out.

S-E-C-R-E-T.

7. Operation of Limit Switches

Protection of the reduction mechanism of the automatic antenna control at large angular displacements is ensured by means of limit switches 31KV1 and 31KV2 for altitude, 31KV3 and 31KV4 for azimuth, and 31KV5 and 31KV6 for tilt.

The flat reflector of the antenna may deflect until closure of the corresponding microswitches takes place:

for elevation: down KV2, up KV1
for azimuth: to the left KV4, to the right KV3.

The tilt platform deflects to the left until closure of the KV6 microswitch, to the right -- the KV5.

Section 7. Indicator Channel

The indicator channel operates in scanning and aiming modes and provides the following:

a) observation of signals from targets detected by the set;
b) determination of distances to the target;
c) determination of azimuth location of targets and estimation of their elevation;
d) possibility of bringing aircraft on target for lock-on and automatic tracking;
e) determination of missile launch zone limits;
f) signaling break-off-attack time;
g) signaling of presence of noise interference;
h) signaling of radar functions in the "monitoring" mode.

Components of the indicator channel are located in the following units:

a) in the TsD-34TPM indicator, serving for observation of signals;
b) in the TsD-46 sweep unit which, together with the TsD-34TPM unit, generates sweeps: of type "B" in scan mode, and of "floating spot" type in aiming mode;
c) in the TsD-36 unit, which produces markers of the type "Top-Bottom", making it possible to estimate position of the target with respect to elevation;
d) in the TsD-25TK suppressor and synchronization unit, which synchronizes the operation of the indicator system and forms the integrated target pulse;

S-E-C-R-E-T

50X1-HUM

e) in the TsD-31TP antenna, which supplies voltage from the azimuth and tilt selsyns for synchronizing the sweep with the position of the beam in the space, as well as GON voltage for forming markings of the type "Top-Bottom" and for forming the target marker in the form of a solid line in the scanning mode. In addition to that, the antenna radiates and receives high-frequency signals;

f) in the TsD-37 unit, which supplies the following: the voltage U max., which is necessary for forming the missile launch zone on the indicator screen. This zone varies with the closing rate on the target and the flight altitude of the interceptor.

-range mark, which makes it possible to determine target range;

-dangerous range signal, at which the pilot must execute break-off;

g) in the TsD-32TK transmitter, which produces RF pulses and converts the received RF signals into IF signals;

h) in the TsD-33 receiver, which amplifies the IF signals and converts them into video signals;

i) in the TsD-26TK noise frequency indicator, which gives out a signal when there is noise interference of sufficient intensity.

The target image is reproduced on the same CR tube in both scanning and aiming modes.

Plotted on the indicator screen are:

a) azimuth and range scales in the scanning mode;
b) azimuth, elevation and range scales in the aiming mode.

The indicator screen, in both scanning and aiming modes, is represented in Fig. 12.

1. Operation of Indicator Channel in Scanning Mode

The indicator channel, in scanning mode, operates as follows:

On the indicator screen is formed a "B" type sweep/raster/ in coordinates azimuth -- range. Targets are represented within the limits of the raster in the form of bright horizontal lines. Location of the target mark on the raster of the indicator determines the range to the target, and its azimuthal position relative to the line of flight of the aircraft. Coordinates of the target are determined by projecting the center of the target mark on the range and azimuth scales of the TsD-34TPM unit.

S-E-C-R-E-T

50X1-HUM

50X1-HUM

When the target is located within the limits of the center scan line, the target immage on the indicator screen is represented in the form of a bright horizontal mark with vertical lines above and below the target mark. If the target is located above or below the center scan line, its image is represented by a horizontal target mark with vertical lines only above it or below it correspondingly.

In scanning mode the indicator channel provides the following:

a) range sweep intensity pulse;
b) range sweep;
c) azimuthal sweep;
d) "Top-Bottom" markings;
e) erasing pulses.

a) Forming of Intensity Pulses

Formation of the range sweep intensity pulses in the scanning mode is produced by a circuit which consists of the 46L3 intensity multivibrator and a cathode follower -- left half of 46L4.

Multivibrator 46L3 is triggered in the scanning mode by positive pulses, coming from the TsD-25TK unit with T9 frequency, through closed contacts 3 and 4 of the 46R1 relay. From the multivibrator output, positive and negative polarity pulses, of T_o duration, are taken. Positive pulses enter the modulator of the recording projector of CRT34L1 of the TsD-34TPM unit through the pulse intensity cathode follower (left half of the 46L4). The negative multivibrator pulses enter the input of the range sweep formation circuit in the scanning mode.

b) Forming the Range Sweep in the Scanning Mode

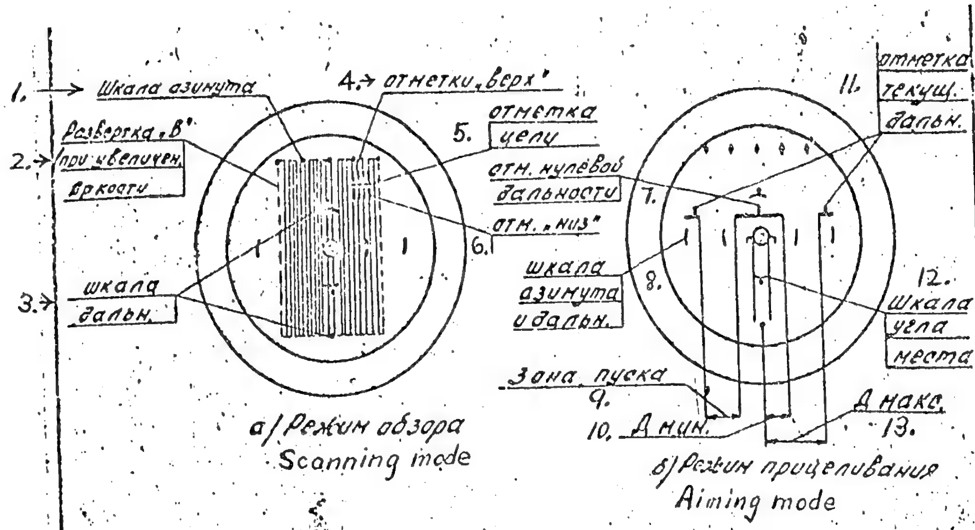
Formation of the range sweep in the scanning mode is accomplished by a circuit consisting of sawtooth voltage generator (right half of the 46L4) and sawtooth current generator 46L5.

Operation of the generators is controlled by the negative pulses of the intensity multivibrator, of T_o duration, which are supplied to the input of the sawtooth voltage generator. The sawtooth voltage generator generates linearly increasing sawtooth voltage. This voltage reacts on 46L5 sawtooth current generator, as the result of which linear sawtooth current runs through the vertical deflection coil 340K1 (3 to 4), which is the 46L5 tube load. Duration of the sawtooth current corresponds to the duration of the intensity pulse; that is, it is equal to T_o.

S-E-C-R-E-T

50X1-HUM

50X1-HUM



Фиг. 12 Вид экрана индикатора в режимах обзора и прицеливания.

Figure 12. Indicator Screen in Scanning and Aiming Modes:
1. azimuth scale; 2. "B" scan with increased intensity; 3. range scale; 4. "top" markers; 5. target marker; 6. "bottom" markers; 7. zero range marker; 8. azimuth and range scale; 9. firing zone; 10. Dmin; 11. present range marker; 12. elevation scale; 13. Dmax.

S-E-C-R-E-T

50X1-HUM

c) Azimuthal Sweep Formation

Azimuthal sweep is formed by an oscillator, consisting of a phase detector circuit with 46D14 and 46D15 crystal diodes, whose load is 340K1 (1 and 2) horizontal deflection coil.

Two voltages are supplied to the circuit input:

a) error signal voltage -- AC voltage of 400 cycles per second from azimuthal selsyn 31Sn2 (1 and 2);
b) reference voltage of 115v 400 cycles per second.

When the antenna is in zero azimuth position, the selsyn voltage is equal to zero. Increasing the antenna deflection angle from zero azimuth increases the voltage amplitude. Voltage phase depends on the direction of movement of the antenna with reference to zero (to the left or to the right).

d) Formation of "Top-Bottom" Markings

Scanning the space for tilt and azimuth is done by three azimuthal lines: upper I, middle II, and lower III. The target image on the indicator screen depends on the target's elevation in space.

The markings, reflecting target's position (in elevation) relative to the interceptor, are produced by the TsD-36 circuit for the formation of the "Top-Bottom" markings.

e) Formation of Erasing Pulses

The erasing circuit, located in the left half of 34L2, consists of blocking oscillator circuit with independent drive, which generates pulses of various frequency for both modes (scanning and aiming). The quality of the image depends on the degree of erasing of the potential image, generated over the target by electron beams of the recording and the reproducing projectors.

The set has two types of erasings: continuous and instantaneous. Continuous erasing is the result of the continuously supplied erasing pulses from 34L2 blocking oscillator to the target of the tube.

For instantaneous erasing, TsD-34TPM unit has a 34Kn1 "Mgn. stir." (instantaneous erase) button.

2. Operation of the Indicator Channel in the Aiming Mode

After target lock-on the indicator device is switched to aiming mode by relays of the TsD-42, TsD-46, and TsD-34TPM units.

In this mode, the indicator screen shows an artifical target mark -- "ptichka" (bird), which consists of two (left and right) range sweeps joined at their starting ends. Each range sweep has an unilluminated portion called "firing zone". "Firing zones" are symmetrically situated with respect to the symmetry center of the "bird". This type of range sweep is determined by the shape of range sweep intensity pulses.

The point connecting the two beginnings of the left and the right sweeps, is the center of symmetry of the "bird". At the center of symmetry and on the range sweeps are corresponding vertical lines of zero and present range.

The position of the range markings on range sweeps on the "bird" determines the range to the target, and the position and size of the "firing zones" determines the limits of the firing zone.

Position of the zero range "marker" marking on the indicator screen, corresponds to the target position in space.

Deflection of the zero range mark from the zero of azimuth or elevation, marked on the dial of the screen's protecting glass, is proportional to target's angle of deflection from the longitudinal axis of the aircraft in the corresponding planes.

Because the markings of the present range are symmetrical with respect to the center of symmetry, range to the target is determined by the distance from the central "marker" to the vertical range markings.

In the aiming mode the indicator channel provides the following:

a) range sweeps;
b) range sweep intensity pulse;
c) zero and present range markings;
d) azimuthal sweep;
e) elevation sweep.

a) Formation of Range Sweep

The range sweep in the aiming mode is produced by a circuit consisting of the following:

- 46L6 trigger;
- paraphase amplifier, left half of 46L7;
- differentiating circuits;
- 46L8 phantastron;
- 46L9 multivibrator;
- 46L10 sawtooth current oscillator II.

Degree of deflection of the beam to the left and to the right from the beginning of the sweep (linear dimension of the "wings") depends on the amplitude of phantastron and multivibrator pulses respectively. Duration of these pulses is made equal to T_p by selecting components which determine the 46L8 phantastron and the 46L9 multivibrator time constant. Required amplitude is obtained by means of potentiometers, located on the front pannel of the TsD-46 unit.

b) Formation of the Range Sweep Intensity Pulse Circuit

A nonuniform illumination of the range sweep in this mode is ensured by a suitable intensity pulse shape. The intensity pulses in the aiming mode are composite and are produced by superimposing over the positive long duration pulses two types of pulses of shorter duration: negative of the "firing zone" and positive range pulses. The first produces on range sweep lines darkened sections / "firing zones" /, and the second ensures even illumination of the range markings in the bright section of the "wing", as well as in the darkened "firing zone".

The "firing zone" pulse is produced in TsD-46 unit, and the range pulse in the TsD-37 unit.

The size of the darkened section produced by the "firing zone" pulse, and their position on the range sweep, vary with the "firing zone" pulse duration and the location of its front and back edges, depending on the closing speed of the interceptor with the target and the altitude of the interceptor.

c) Formation of the Zero and Present Range Marks

The zero range marks on the "bird" and the present range marks are produced by the TsD-46 unit.

S-E-C-R-E-T

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

d) Formation of the Azimuthal Sweep

Deflection of the "bird" with respect to the azimuth is produced by the same circuit which produces the azimuthal sweep in the scanning mode, the difference being that the voltage proportional to the antenna azimuth is supplied to the azimuth phase detector not from the 31Sn2 (1:2), but from the third phase of the 31Sn3 (1:4) selsyn. This is done in order to change the deflection scale in the azimuthal plane. In addition, the GON of the TsD-31TP unit is disconnected from the circuit.

Switching of the selsyns and the GON is made by relays 46R3 (contacts 6, 7, and 8) and 46R6 (contacts 7 and 8).

e) Formation of the Elevation Sweep

Deflection of the "bird" with respect to elevation is produced by a circuit identical to the azimuthal sweep circuit located in the TsD-46 unit.

3. Operation of the Indicator Channel in Presence of Noise Interference

When noise interference of sufficient intensity is present, the TsD-26TK noise indicator circuit, consisting of 26L1, 26L5, and the left half of 26L9, supplies voltage of +27v. This voltage enters the warning light, 34Ln8 "P" (interference), which lights up and warns the pilot of the necessity to switch the set to "Interference" mode. In this mode, artificial target pulses are supplied through TsD-25TK unit to the input circuit of the TsD-36 unit's "Top-Bottom" markings circuit.

These pulses are generated by the artificial target formation circuit which is located in TsD-26TK and consists of 26L10 and 26L11.

4. Operation of the Indicator Channel in the Presence of the Dangerous Closing Range Signal

When the interceptor closes with the target to within D op. sb. a dangerous closing range signal (+27v) is supplied from the TsD-37 unit to the "O" ("break-off") light on the TsD-34TPM unit.

[redacted]

Section 8. Smooth Noise Interference Channel

The following is provided by this channel:

1. indication of smooth noise interference, by ignition of the "P" display on the TsD-34TPM unit;

2. after changeover to the noise interference mode of operation, indication of the source of noise interference by means of the TsD-34TPM unit's indicator screen;

3. automatic tracking of the source of noise interference by angular coordinates without determination of its range.

The channel consists of the following:

a) TsD-33 receiver, designed to amplify noise interference of the intermediate frequency and to supply the interference video signals to TsD-40TK and TsD-26TK units;

b) TsD-26TK noise interference indicator unit, designed to supply voltage of +27v to the "P" lamp on the TsD-34TPM unit when smooth noise interference is present, and to generate the artificial target pulse and ShARU wide gate in the interference mode;

c) components (relays) of the TsD-42 unit, which ensure operation of the channel and connection with other units.

Appearance of smooth noise interference in the target scanning mode is received by the set as an increase in the amplitude of noises at the receiver's output in the wide gate and the ShARU gate. Due to the pulse interference limiter -- left half of 33L15, the ShARU circuit of the receiver does not fully eliminate the increase in noise.

Noises from the cathode follower of the left half of 33L23 of the receiver enter the 26L1 coincidence stage of the TsD-26TK noise interference indicator unit through F15 coaxial cable.

When the "Interference" light goes on and the target on the indicator screen of the TsD-34TPM unit disappears, the pilot switches the "Interference - Tracking - Locked-on beam" toggle switch on the TsD-41UTPM unit to position "Interference". This switches the set into tracking mode by smooth noise interference.

[redacted]

Tracking by Smooth Noise Interference

After the "Interference - Tracking - Locked-on beam" toggle switch is switched on, +27v voltage is supplied to 42R20 and 42R20-1 relay windings. At operation of these relays, stabilized voltage of +150v is supplied through contacts 4 and 5 of 42R20-1 relay to the artificial target channel and the winding of 26R6 relay, which decreases the level of interference indication.

Triggering pulses are supplied from the TsD-25TK unit, through contacts 4 and 5 of the 42R20 relay, to the trigger of the 26L6 delay phantastron in the ShARU wide gate formation circuit.

When the "Interference" toggle switch is on, the noise interference passes to receiver's output only in the ShARU wide gate.

The noises in the ShARU wide gate enter first the two-stage 26L10 (6N1P-V) amplifier and then the trigger of the 26L11 (6N1P-V) artificial target blocking oscillator.

The blocking oscillator generates pulses of 0.9 ± 0.1 microseconds, which enters the indicator channel through contacts 7 and 8 of the 42R28-1 relay and the TsD-25TK unit.

The artificial target with "Top-Bottom" markings appears on the indicator screen lines of the scanning zone. The position depends on the source of noise interference. The position of the target mark on the indicator with respect to the azimuth determines the target azimuth angle.

Information on the distance to the target pilot receives from the ground.

Pilot's task in the smooth noise interference scanning mode is to bring the target on the center line and lock-on zone with respect to azimuth. After this the set is switched to aiming by smooth noise interference by pressing the "Lock-on" button.

Aiming by Smooth Noise Interference

In the aiming mode the pilot watches the "bird" on the indicator screen. Relative position of the "bird" with respect to the center of the screen corresponds to the position of the target in space with respect to angular coordinates. The range markings are absent on the "bird"

When switching to aiming by interference, voltage of +27v is not supplied to the 26R7 relay winding and the command for switching on range scanning is not sent to the TsD-37 range unit. Firing of missiles is carried out by the pilot on a special signal.

Section 9. Coupling Channel of the R-2L Radar with the Missile Firing Circuit

Firing is permitted when the range markings on the "bird" are inside the firing zone, and the "bird's" center marker is inside the small circle of the indicator scale.

Missiles are fired on a special signal which indicates that the missile head is locked on the target.

Section 10. Coupling Channel with the VPD-30 Altitude Instrument

The maximum range of the permissible firing zone on the set's indicator increases smoothly with increase in flight altitude. For this purpose, a potentiometer in the VPD-30 altitude data unit is used to which is supplied 400-cycle voltage from 42Trl transformer windings 10 and 11. Voltage from the VPD-30 is supplied to the TsD-37 unit.

Section 11. Control Channel of the Set

The set is fully controlled in the air from the cockpit by means of control devices located on the TsD-41UTPM control panel, on the aircraft control stick, on the front panel of the TsD-34TPM indicator, above the instrument board, and on the left and right panels of the cockpit.

During ground operation, unit TsD-48 is connected to the set. By means of this unit a whole series of operations, described in the "TsD-48 Ground Test Unit" section are carried out. This section discusses only control devices of the TsD-48 unit, which switch on the set (both preliminary and full), switch off magnetron filament and operating section of the TsD-32TK unit, switch off the antenna motors (of azimuth, elevation, tilt and scanning).

The following operations are done by means of a toggle switch located on the TsD-41UTPM control board:

- preliminary switching on of the set (without the high voltage);
- full switching on of the set;
- switching on "tracking", "locked-on beam" and "interference" modes;
- switching the high-frequency energy radiation of the set's transmitter from the antenna to the antenna equivalent, and vice versa.

[redacted]

By means of the buttons "Zakhvat" (on the control stick), "Sbros" (on the left side above the instrument board), "Pusk" (on the control stick), "Mgnov. stir." (instantaneous erase) (on the front panel of the TsD-34TPM), the following are done, respectively:

- switching the set from scanning mode into the "DU" and lock-on target mode;
- breaking off the locked-on target;
- missile firing;
- instantaneous erasure of the image on the indicator screen.

By means of toggle switches "Protection of R-2L against ground [noise]", "Protection of R-2L against passive ECM" the following are done, respectively:

- lower antenna line is disconnected, which considerably decreases the ground echo;
- switches on the discrimination circuit for closing-in rate, which provides protection for the set from chaff released by the target aircraft.
- scanning section is displaced with respect to aircraft's longitudinal axis.

1. Preliminary Switching on of the Set (without the high voltage)

Preliminary activation of the set is accomplished by placing the toggle switch, located on the TsD-41UTPM unit, in position "Set On". This grounds B contact of the contactor winding for switching-on in 42R11. The contactor operates because voltage of +27v, from the aircraft circuit, is supplied to the A contact of its winding.

2. After the complete cycle of operation of a group of relays which switch on high voltage in the TsD-42 unit, voltage of +27v is supplied to the 2nd contact of the 41V1 toggle switch.

In this state the set is ready for high voltage.

After setting the toggle switch in position "High Voltage On", voltage of -27v is supplied through contacts 37Sh20, 1Sh29 and 10Sh2 to the 32R2-1 relay winding. The relay operates, its contacts break the supply circuit of the 32Tr2-8 magnetron filament transformer, supplying power to the primary winding of the high-voltage transformer Tr2-1. High voltage is on.

3. Radiation or Antenna Equivalent Operation

So that the set can operate secretly in the air and on the ground, without radiating RF energy into space, operation on antenna equivalent is provided. High-frequency energy is switched from the antenna to the

[redacted]

[redacted]

equivalent by TsD-29TPM unit on a command from the TsD-41UTPM board. Switching the set to equivalent while the aircraft is parked also precludes possibility of the crystals' receiving high intensity RF energy from nearby sources.

4. Scanning

Operation of the set in the scanning mode is achieved by placing the set's mode toggle switch, located on the TsD-41UTPM unit, in "Soprov." (tracking) position.

5. Ranging System

Ranging mode is characterized by having the antenna in "DU" position, scanning the target for range.

DU mode is switched on by pressing the "Zakhvat" (lock-on) button.

Stabilized voltage of -250v is supplied though contacts 4 and 5 of the 42R5-1 relay to 37L10 automatic lock-on device, preparing it for target lock-on.

6. Automatic Tracking

If the pilot correctly aims his aircraft at the target and the reflected target signal is of sufficient intensity when the "Lock-on" button is pressed, the tracking system of the TsD-37 unit will lock on the target with respect to range, after which the automatic lock-on 37R1 and 37R2 relays, operates.

After the set has locked on the target, the "Lock-on" button on the aircraft control stick may be released.

As the result of the error signal and reference voltage comparison, the TsD-40TK unit produces azimuth and elevation control currents, which ensure antenna operation in the direction of diminishing signal error, i. e., in the automatic tracking mode the antenna tracks the target.

7. Locked-on Beam

This mode is used by the pilot when the sighting of the target can be done by optical means, that is when the target is in view.

To switch on the "lock-on beam" mode, the 41V2 toggle switch is placed in position "Zakr. luch (locked-on beam).

The pilot brings his aircraft on the target by means of the optical sight, and when the intensity of the reflected signal becomes sufficiently large, the automatic target lock-on device located in the

[redacted]

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

TsD-37 unit operates. The pilot is made aware of this by the termination of target scanning; the range markers on the wings of the "bird" stop on the present range to the target.

Firing zones appear on the bird.

8. Operation of the Set by Smooth Noise Interference

a) Noise Interference Indicator

Noises at the receiver output in the ShARU gate, via RF plug FIS and ShARU gate pulses from the TsD-25TK unit, are supplied to the noise indicator circuit in the TsD-26TK unit. At the same time, voltage of -27v is supplied to the lamp "P" located on the front panel of the TsD-34TPM unit.

b) Scanning by Noise Interference

When the pilot receives the interference signal, he switches the 41V2 toggle switch to position "Interference".

Target indication in the "interference" mode of scanning is obtained in the same manner as in the regular scanning mode, with the exception that in the "interference" mode the artificial target is at fixed range. Information about the true range to the target is received by the pilot from the ground.

The pilot, as in the regular scanning mode, brings his aircraft on the target so that the target is on the center line and inside the lock-on zone with respect to azimuth.

c) Noise Interference Automatic Tracking Mode

The radar is converted to the noise interference automatic tracking mode by pressing the "Zakhvat" button.

Noise interference is tracked in the same manner as when tracking a signal reflected from a target.

When operating in this mode units TsD-40TK and TsD-44TP guide the radar antenna toward the source of noise interference. Units TsD-46 and TsD-34TPM are used to display the "bird" aiming marker. There are no range markers on the "bird" when operating in the "noise" mode.

S-E-C-R-E-T

9. Protection of the Set Against Ground Noises

When operating in the scanning mode at flight altitudes less than 1,000 meters, the ground surface is irradiated and the screen is illuminated by reflections from the ground. In order to make it possible to use the radar at low altitudes under combat conditions, the set provides for deactivation of the lower azimuth line during scanning and a displacement of the scanned sector upward relative to the longitudinal axis, which is accomplished by means of the toggle switch marked "Zashchita ot zemli" (protection against ground [interference]) in the pilot's cockpit.

10. Protection of the Set Against Passive ECM

The set provides for selection (discrimination) of the closing speed of the interceptor with a target, which ensures protection of the set against passive ECM (chaff) dispersed by the target aircraft in the form of dipole reflectors. The principle of selection is based on a comparison of the speed of the interceptor and its closing speed with the target.

When the speed selector is switched on, the possibility of aiming on slowly moving or stationary targets is eliminated. The capability of tracking a slowly flying target is provided in the set by disengaging the speed selector by means of the toggle switch marked "Zashchita ot passivnoy pomekhi" (protection against passive ECM).

11. "Firing"

The pilot aims or guides his aircraft toward the target so that the center of the "bird" is within the small circle on the scale of the indicator.

The pilot releases his missiles by pressing the "Pusk" (fire) button.

Section 12. Radar Monitoring Channel

A functional diagram of the monitoring channel is given in fig. 13 (book of diagrams).

The monitoring system is switched on when the set is operating fully by placing toggle switches V2, V3 of unit TsD-41UTPM in the positions "Soprov." (track.) and "Kontrol" (monitor), respectively.

The aircraft circuit voltage of +27v is fed through contacts 2 and 4 of toggle switch 41V3 to unit TsD-42 through 33Sh19.

In unit TsD-42 the +27 v is fed through normally closed contacts 3 and 4 of 42R30 to the following relays:

1. 42R29, which triggers and:

a) disconnects unit TsD-32TK from unit TsD-36 and connects it to unit TsD-26TK with its contacts 5 and 4;

b) with contacts 6,7, and 8, switches the plate voltage of the IF amplifier of unit TsD-33 for the purpose of reducing the amplification factor;

2. 42R23, which triggers and:

a) with contacts 3 and 4, ungrounds contact 7 of relay 42R5 to interrupt triggering of the receiver and, through contacts 4 and 5, grounds R103 in unit TsD-36 to reduce the gain of the video amplifier;

b) with contacts 7 and 8, removes the artificial target pulse from 15Sh25, since at this stage of monitoring the target pulse for the indication channel comes from unit TsD-33.

3. 42R28-2, which triggers and:

a) with contacts 5 and 4, sends -250 volts to unit TsD-37 and the speed selector circuit to check its operation in the event that toggle switch 41V2 has been placed in the position "Zakr. luch" (locked-on beam) in the first stage of monitoring;

b) with contacts 6 and 7, connects a 400-cps voltage from 44Tr1 to the amplifier of the tilt channel, which causes unit TsD-31TP to generate a tilt to the right.

4. 42R28-1, preparing this relay for operation in the event that the right-side tilt limit switch operates.

5. 42R28, which triggers and with its contacts 3 and 4 ungrounds relay 42R26 which unblocks the "Pomekha" (noise) toggle switch, and ungrounds relay 42R19-2 to prevent it from operating upon reception of the 14-kilometer command and ensures a -250 volt supply to unit TsD-37 and the "dangerous range" circuit.

A voltage of +27 v is also sent from contact 4 of relay 42R30 to:

1. unit TsD-26TK for operating relay 26R9, which triggers and:

a) with contacts 6 and 7, triggers the artificial target blocking-oscillator 26L11 (and consequently unit TsD-32TK) from the SHARU wide-gate blocking oscillator;

50X1-HUM

b) with contacts 3, 4, and 5, triggers the ShARU wide-gate pulse-shaping circuit with a trigger pulse from TsD-32TK (27Sh26), which ensures operating of this circuit in the first stage of monitoring.

2. unit TsD-33 for operating relay 33R4, which triggers and:

a) with contacts 6 and 7, sends a voltage from the reference signal generator to the input of cathode follower 33L21 (right side), which modulates the test signal in unit TsD-40TK, for the purpose of moving the antenna reflector to the right and upwards in the second stage of monitoring;

b) with contacts 4 and 3, disconnects the (ARU) circuit and, with contacts 4 and 5, connects a negative voltage to the grids of the IF amplifier tubes for the purpose of fixing its gain in the testing mode.

3. unit TsD-34TPM through 42R19 and 42D7 to the "Pomekha" (noise) lamp 34LN3, which burns at half-intensity during the first and second stages.

In the first monitoring stage the screen of unit TsD-34TPM will show in the middle range a line with "Verkh-Niz" (top-bottom) markers along the entire azimuth, lamp "P" will burn at half-intensity, and unit TsD-31TP will tilt the antenna to the right.

If toggle switch 41V2, in its first stage, is set in position "Zakr. luch," then on screen of unit TsD-34TPM will appear a "bird" with range marks at its ends, which move in the direction of the greater range.

When the toggle switch is placed in position "Soprov ", then the monitoring cycle continues.

When 31KV5 operates, its contacts 3 and 4 will ground the following units to the frame (beginning of the second stage of monitoring):

a. 42D2I, the lamp "P" begins to flicker;

b. 42DII, now relay 42R28-1 operates and with its contacts 4 and 5 grounds auto-blocking and reduces the phantastron pulse duration in unit TsD-26TK to 15 microsec.

Now contact 3 of relay 42R28-1 ungrounds so that relay 42R28-2 releases and unit TsD-31TP returns to zero tilt.

Contacts 7 and 8 of relay 42R28-1 will supply /27 voltage to the button circuit "Zakhvat" and will operate all relays of mode "DU" (42R5-1; 42R5-2; 25R1; 40R3).

50X1-HUM

The monitoring signals, after being modulated by voltage from the reference voltage generator is fed to unit TsD-40TK and makes the antenna reflector (mirror) of unit TsD-31TP move right-up.

During the second monitoring stage, on the screen of unit TsD-34TPM the "bird" will appear with range marks and launching zones, which will move right-up on the screen. Lamp "O" will light. After both limit switches 31KV1 and 31KV3 have operated, the relay 42R10 will also operate and will connect with contacts 6 and 7, the relays 42R30 and 42R31 to ground (beginning of the third stage of monitoring).

When relay 42R31 operates, it:

a. disconnects with contacts 7 and 8 the tracking relay 40R1 and 40R2 of unit TsD-40TK from ground;

b. connects with contacts 7 and 6 relays 42R6 and 42R6-1 to ground;

c. connects with contacts 7 and 6 relay 33R163 to ground for switching the mode of the ShARU circuit of unit TsD-33. This results in a sharp rise of noises.

Now relay 42R30 operates and disconnects the /27 voltage from all the above-mentioned consumers, as well as from lamp "P" of unit TsD-34TPM. Lamp "P" will not be lit brightly from the noise-indicator circuit, while the "bird" will shift to the center of the screen without launching zones, with range markers moving from the center to the edges of the "bird".

This indicates that the radar has entered the third and last monitoring stage.

If at this time toggle 41V3 is set in the mode "Ekviv" (equivalent) or "Izl." (radiation), then the radar will switch to the scan mode.

If it is necessary to repeat monitoring system operation, set the toggle 41V3 again in position "Kontrol'" (monitoring).

It should be remembered that for proper checking of the aircraft monitoring system, the aircraft should not be tilted more than 10°.

Section 13. Radar Power Supply

The radar requires for its operation the following power sources:

a. dc /27 voltage,

b. ac 115-v, 400-cps,

c. ac 115-v, 600-800-cps,

d. ac, 3-phase, 36-v, 400-cps.

The stabilized dc voltages of +150, +250, -250 and +300 are supplied from radar rectifier Ts-D-38. The +27 dc voltage is drawn directly from the aircraft network.

Converter PO-1500 supplies 115-v, 400-cps ac voltage.

Generator type SGO-8 supplies 115-v, 600-900-cps ac voltage.

Converter type PT-500Ts supplies the 3-phase, 36-v, 400-cps voltage.

Current consumption in various circuits:

+27-v aircraft network	12 a
115-v, 400-cps	11.5 a
115-v, 600-900-cps	11 a
36-v, 400-cps	0.8 a per phase
+150-v stabilized	225 ma
+250-v "	585 ma
-250-v "	200 ma
+300-v "	75 ma

PART TWO

DESCRIPTION OF UNITS OF THE R-2L RADAR

Chapter Four

THE TsD-31TP ANTENNA

Section 1. General Description of the Unit

The TsD-31TP antenna enables the set to operate in the search and automatic target tracking modes. To perform these functions, the antenna unit forms the energy channeled from the transmitting system into a narrow scanning beam. The electromechanical systems of the antenna unit make it possible to nutate the beam in azimuth and elevation, to stabilize the beam in space in the search mode, and to generate voltages proportional to the beam deflection angles for definition of antenna scan zones and for forming sweeps of the TsD-34TPM indicator.

Section 2. Basic Technical Data of the Unit

1. The amplification factor is 1,100.

2. The electrical durability of the channel makes it possible to propagate R-F energy up to 100 kw per pulse.

3. In the frequency range $f_s \pm 2\%$, the standing wave ratio at the input of the waveguide is no greater than 1.5.

4. The scanning rate is T30 ± 3% cps.

5. Power requirements are for 115-volt, 400-cycle, 2.5 amperes and ±27-volt, 2.5 amperes.

6. Attenuation of the directional coupler is 30 db.

7. The weight of the unit is 31.5 kg.

Section 3. Focusing the Energy into a Narrow Directional Beam

The directional emission of energy in the given antenna system is accomplished with a conical radiator and a parabolic mirror. An equal-signal directivity is provided by the rotation of the radiator with the phase center shifted in relation to the axis of rotation. Azimuthal and elevation deflection of the beam is accomplished with a plane mirror.

Spherical electromagnetic waves are emitted from the radiator and then fall onto the parabolic mirror. Because of the properties of the parabola, the spherical waves falling on the mirror are, after reflection, formed

S-E-C-R-E-T

into planar waves. After reflection from the parabolic mirror, the energy falls on the plane mirror and is reflected from it; it is then propagated into space as a narrow beam. Reflection of the energy during its first incidence on the parabolic mirror and its free propagation after its second incidence is accomplished by the special design of the mirror and by the stability of the polarization plane of the waves emitted from the radiator.

Using the parabolic and plane mirror combination permits the use of a waveguide of simple design and makes it possible to obtain sufficiently large azimuthal and elevation deflection angles of the beam while employing small mechanical deflection angles in the moving parts of the antenna.

Section 4. The Waveguide

The waveguide is intended for channeling the energy from the outlet of the TsD-29TDM unit to the radiation system. The waveguide consists of individual components, which perform specific functions.

1. The Radiator Rotation Joint

The radiator rotation joint is intended for emission of energy without reflection at the junction point of the fixed and movable waveguides. This joint is made from a round waveguide.

2. Transition From the Round to the Rectangular Waveguide

The match between the round and the rectangular waveguide is accomplished with a quarter-wave transformer. The quarter-wave transformer consists of a section of waveguide, the cross-section of which is the mean between the round and the rectangular waveguide.

3. The Tilt Rotation Joint

The tilt rotation joint makes it possible to propagate the energy along the waveguide with the antenna stabilized for tilt. The joint consists of a rotatable coaxial device.

4. The Connecting Waveguide

The connecting waveguide is intended for channeling the energy from the TsD-29TDM unit to the tilt rotation joint. Choke flanges with sleeve nuts are provided at the ends of the connecting waveguide for coupling it to other waveguide sections.

Section 5. Description of the Unit's Circuit

The circuit diagram drawing of the unit is given in Fig. 14 (see diagram book).

1. The Scan Component

The scan component is used to form an equal signal voltage and to provide the reference voltages. To perform these functions, the component has an M4 servo motor and a GON-1 reference voltage generator.

To shield the supply circuits from interference caused by brush sparking and regulator contacts, the component has a filter consisting of two capacitors (C12 and C13). The wiring of all elements of the scan component is arranged into a harness and is led out of the scan mechanism housing through a sealed pin connector.

The GON-1 reference voltage generator is of the alternating current type. The stator has two windings shifted with respect to each other so that the voltage on the generator terminals is shifted in phase. The amplitude of the voltage is constant because the rotation of the shaft is constant.

2. The Azimuth Beam Control Component

The function of the azimuth component is to deflect the beam in the horizontal plane according to a given arrangement in the search mode, to track the beam on the target with a rate proportional to the movement of the target in the tracking mode, and to provide a voltage to the TsD-46 sweep unit in the search and automatic target tracking modes.

The following elements are located in the azimuth component:

a) M2 actuating motor,

b) TG2 tach generator

c) Sn3 and Sn2 selsyns,

d) KV4 and KV3 limit switches.

a) The M2 actuating motor is an ac, induction, single-phase, capacitive, electric machine with a low-inertia, nonmagnetic rotor.

b) The TG2 tach generator is used to provide a feed-back voltage in the azimuth magnetic amplifier circuit. It is a dc machine with permanent magnet excitation.

c) The function of the Sn3 selsyn is to supply voltages required to move the beam in the proper way in the search mode, to set the plane mirror in the zero azimuth position in the DU mode, and to supply voltages proportional to the movement of the target in relation to the equal-signal voltage in the tracking mode.

50X1-HUM

The function of the Sn2 selsyn is to form the azimuth sweep voltage in the scan mode generated by the TsD-46 sweep unit. The selsyn rotor is mechanically coupled with a ratio of 1:2 with the azimuth loop. A potential of 115-volt 400-cycles is fed to the rotor brushes.

d) The KV4 and KV3 limit switches function to limit the travel of the mirror. When the limit switches are closed, the relay circuit in the TsD-42 unit, controlling the circuit limiting the movement of the plane mirror to the right and left, is grounded.

3. The Beam Elevation Control Component

The elevation component functions to deflect the beam for elevation during search and track modes and to supply voltages proportional to the elevation angle of the beam to the TsD-40TK antenna control unit and to the TsD-46 sweep unit.

The elevation component has the following elements:

a) M1 actuating motor,

b) TG1 tach generator

c) Sn1 selsyn

d) KV2 and KV1 limit switches.

In the elevation component are the same electric machines as in the azimuth component which perform the function of the actuating motor and the feedback element. Power supply of the M1 motor and the TG1 tach generator circuit is accomplished in the same way as in the azimuth component. The Sn1 selsyn functions to form voltages proportional to the beam deflection angle for elevation in the search and DU modes and for forming elevation sweep voltages in the automatic tracking mode. The KV1 and KV2 limit switches limit the movement of the plane mirror up and down.

4. The Antenna Tilt Stabilization Component

The function of the antenna tilt stabilization component is to stabilize the antenna in the scan mode up to angles of $\pm 7°$ and to position the antenna in the zero tilt position in the track mode, i.e., to switch-out the tilt stabilizer in the tracking mode.

The tilt mechanism has the following elements:

a) M3 electric motor,

b) TG3 tach generator

S-E-C-R-E-T

50X1-HUM

c) Sn6 flat selsyn,

d) Sn5 selsyn,

e) KV5 and KV6 limit switches.

The principle of antenna stabilization is based on the electrical connection of the two selsyns: the 1186a [sic] signal distributor tilt selsyn and the Sn6 antenna tilt angle selsyn. The 1186A [sic] signal distributor is a follower of the aircraft tilt angle signals generated by the gyroscopic transmitter of the AGD-1 remote gyrohorizon. The transmitting selsyn following the tilt system is mounted on the AGD-1 gyrotransmitter frame. The tilt receiving selsyn is located in the 1186A signal distributor. In the presence of lateral tilt of the aircraft, a misalignment of the AGD-1 transmitting selsyn with the receiving selsyn of the distributor occurs. The error signal in the form of voltage is fed through the amplifier to the winding of the control motor, which through a reducer transmits the rotation to the receiving selsyn rotor of the distributor and brings it into a position corresponding to that of the AGD-1 transmitting selsyn rotor. As the receiving selsyn rotor turns, its movement is transmitted through gearing to the transmitting selsyn rotor of the signal distributor. Thus, the distributor transmitting selsyn rotor reproduces the tilt angles of the aircraft. The distributor transmitting selsyn is connected with the antenna transformer selsyn according to a "transmitting selsyn-transformer selsyn" schematic.

A 36-volt, 400-cycle potential is fed to the transmitting selsyn rotor from the TsD-44TP magnetic amplifiers unit. The current in the rotor winding induces a current in the stator windings as in an ordinary transformer.

Direction of the magnetic flux in the transmitting selsyn depends on the position of the rotor in respect to the stator. Because of the connections between the selsyn stator windings, the flux direction is transmitted to the transformer selsyn. If the rotor of the transmitting selsyn is perpendicular to the flux, the error signal taken from its winding is equal to zero. If the rotor is in line with the direction of flux, the error signal is at maximum value.

Both selsyns are phased so that with zero tilt the rotors are at 90° and the error signal is zero. In the presence of aircraft tilt, the transmitting selsyn rotor turns because of the mechanical coupling with the AGD-1 unit. An error signal appears on the rotor of the transformer selsyn and is supplied through the TsD-44TP magnetic amplifiers unit to the antenna tilt control circuit, from which it is fed to the control winding of the M3 tilt motor. The M3 motor continues to operate until the error signal is reduced to zero. Direction of rotation depends on the phase of the error signal in relation to the phase of the voltage on the line winding of the motor.

S-E-C-R-E-T

50X1-HUM

[redacted]

Thus, antenna stabilization for tilt is achieved. When locked on target, the antenna returns to the zero position irrespective of the tilt of the aircraft, i.e., the tilt stabilizer is switched off.

The Sn5 selsyn functions to ensure the return of the antenna to zero. The Sn5 selsyn rotor is coupled mechanically with the movable part of the antenna with a ratio of 1:2; the rotor also receives a potential of 115 volts at 400 cycles.

A voltage is formed on the stator windings, which is governed by the angular position of the stator and rotor. The phase of the selsyn is arranged so that the rotor is at equal angles to the first and third phases of the stator; hence, with the movable part of the antenna at the zero position, the linear voltage between the first and third phases is equal to zero because the phase voltages are equal and are opposite in phase. During tilting, the linear voltages change sinusoidally. The phase of the voltage indicates the direction of tilt.

Thus, the Sn5 selsyn functions during tilt to produce signals required to return the antenna to the zero position.

The M3 electric motor of the tilt component is of the induction, two-phase type.

The TG3 tachometer is the same kind as in the azimuth and elevation components and is intended for supplying feedback voltages.

The KV5 and KV6 limit switches confine the tilt motion of the antenna to $\pm 78^{\circ}$.

Section 6. Antenna Construction

The whole antenna system consists of two parts: movable and stationary. All antenna elements are mounted on the stationary part of the housing. Three lugs on the stationary part are for fastening to the frame of the aircraft. The tilt stabilization mechanism is secured on top on the machined part of the housing.

A steelcup with four ball bearings is fastened to the lug in the central part of the base. The entire movable part of the antenna is attached to a hollow shaft placed in the inside of the ball-bearing race. A pin connection is mounted on the lug, on the right and to the rear. The tilt limit microswitches are located on the sides of the base rim; the rigid tilt support is on the bottom of the rim. A special opening to three threaded holes for securing the TsD-29-TM unit is located on the bottom rear.

[redacted]

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

The movable part of the antenna is the part of the antenna which moves in relation to the stationary part during aircraft tilt. The movable part is coupled mechanically with the stationary part of the antenna with the help of a sector gear mounted on the movable antenna base rim. The movable part of the antenna includes:

1. The base of the movable part,
2. Parabolic mirror,
3. Plane mirror,
4. Azimuth loop,
5. Azimuth beam deflection component,
6. Elevation loop,
7. Elevation beam deflection component, and
8. Scan component.

All fasteners are on the movable base. The parabolic mirror is mounted on three rigid lugs of the base and is held by six screws. Adjusting plates are mounted between the mirror and the lugs for obtaining the proper focus. The scanning mechanism is located on the bottom front on the movable base. On the front of the movable base, there is a machined lug, in which the radiator is placed. The radiator rotates on two ball bearings held in a steel cup. The scanning mechanism is sealed. The azimuth loop is mounted on the outer part of the lug and is rocked on vertical pivots with ball bearings. The azimuth component is mounted above. Mechanical coupling between the azimuth loop and the azimuth component is accomplished with a sector gear mounted on the azimuth loop. The elevation loop is mounted in front in the central part of the azimuth loop with the help of two horizontal pivots on ball bearings. The elevation component is mounted on the right on the azimuth loop with the aid of three screws. The elevation limit switch mounting plate and the counterweight are mounted on the left. The tilt limit switch catches are mounted on the lower part of the movable base rim; buffers to prevent hard stops during aircraft tilt exceeding 78° are installed on the right and left.

S-E-C-R-E-T

[redacted]

Chapter Five

THE TsD-29TPM "ANTENNA-EQUIVALENT" COMMUTATOR

Section 1. General Description of the Unit

The unit consists of R-F and electromechanical sections. The principal schematic diagram is given in Figure 15 (see diagram book).

The TsD-29TPM "antenna-equivalent" commutator makes possible two modes of operation of the set: transmittal and reception of electromagnetic energy by the antenna and operation with the artificial antenna. Inclusion of the commutator in the set's complement makes secret operation of the set possible during testing and alignment. The commutator channels the energy into the antenna or into the load absorption channel on command from the TsD-41UTPM control panel.

The electromechanical system of the commutator serves to turn the rotor of the waveguide switch, to switch off the transmitter when the rotor of the waveguide switch turns, and to indicate when energy is radiated by the antenna.

Section 2. Technical Data

1.	Pulse peak power	100 Kw
2.	Directional coupler attenuation	30 ±5 db
3.	KSV (standing wave ratio) of the waveguide when operating with the antenna,	1.5
	when operating with the antenna equivalent (maximum)	1.4
4.	Electric servo supply voltage	27 v
5.	Weight of the unit	3 kg
6.	Dimensions:	
	length	380 mm
	width	134 mm
	height	303 mm

S-E-C-R-E-T

[redacted]

The position of the rotor of the waveguide switch corresponds with the mode of operation with the antenna equivalent. When the rotor turns 90° counterclockwise, the energy will reach the antenna. The entire waveguide tract is sealed. The body of the switch consists of a hollow cup with a hermetically sealed cover. In the cup, there are three waveguide windows with geared flanges for connecting the flexible section, the antenna input, and the load absorber.

Two ball bearings, on which the commutator rotor turns, are located at the bottom of the cup and cover. Ball races are mounted in the cover for holding the rotor in extreme positions. The rotor consists of a cylinder with two waveguide windows set at a 90° angle. For matching the waveguide channels, the rotor walls have choke grooves for electrical bonding of joints of the rotor waveguide windows and the body. To prevent energy leakage between the rotor and the body, ferro-epoxy inserts, which absorb the leakage, are fashioned in the walls of the rotor.

The Directional Coupler

The directional coupler in the waveguide system is used for measurement purposes. The directional coupler consists of a section of the main waveguide, a supplementary waveguide section, and a load absorber. Flanges on the main waveguide are for connecting the transmitting system on one end and for connecting the flexible section on the other. A rectangular flange on the supplementary waveguide connects the measurement apparatus; the load absorber is installed at the opposite end of the supplementary waveguide. The main and the supplementary waveguides are welded along the wide wall.

Two round openings in contiguous walls are for electrical connection between the main and supplementary waveguides.

The Antenna Equivalent

The antenna equivalent serves to absorb and dissipate the energy when using the transmitter with the equivalent. It consists of a section of waveguide with attenuation wedges on the inside.

The Connecting Waveguides

One connecting waveguide serves to connect the waveguide switch and the antenna equivalent.

The second connecting waveguide is intended for connecting the measurement apparatus to the directional coupler.

Section 4. The Electromechanical Servo

The principle of operation of the electromechanical servo is based on the property of magnets attracting unlike poles. In this servo, the stator acts as the electromagnet with stationary poles; the rotor, with the position-changing poles. Depending on the relative polarity of the rotor and stator, the rotor will rotate in one or the other direction. The polarity change in the rotor is accomplished by changing t the current direction in the field coil.

The servo stator consists of a magnetic steel cylinder. Pole terminals with the windings are fastened with screws inside the stator. The rotor winding is wound on the rotor, which is made of two halves pulled tight with screws.

The V1 and V2 switch control catch is mounted on the upper end of the rotor shaft. The dog on the lower end of the shaft serves as a connection with the rotor of the waveguide switch.

Section 5. Description of the Circuit

Position of the servo rotor in the circuit corresponds with the set's mode of operation with the antenna equivalent or with the set turned off. When the "Izluch.-Ekvival." (radiation-equivalent) toggle on the control panel is in the "Izluch." position, +27 volts is fed through pin 2Sh29 to the R1 relay winding.

When contacts 7, 6, and 4, 5 of the R1 relay close, the rotor and stator windings of the servo are connected in series and are connected to the +27-volt (aircraft) circuit. When thus connected, different polarities are induced at the ends of the rotor and stator; the rotor rotates through 90° (to the point of coincidence of the opposing poles).

The normally-closed contacts 1 and 2 of V1 [i.e., of the V1 microswitch] open and break the +27-volt supply circuit (i.e., the transmitter high-voltage is switched on); this disrupts the arrival of energy from the transmitter at the waveguide input during channel switching.

The position of the rotor is retained by a ball race. When contacts 1 and 2 of the V2 microswitch close, +27 volts is supplied to D1 and, subsequently, to the TsD-32M unit for switching on the high voltage.

For operation with the antenna equivalent, the "Izluch.-Ekvival." toggle is placed in the "Ekvival." position. This removes the +27-volt potential from pin 5Sh29. The R1 relay is de-energized. Contacts, 8, 7 and 3, 4 of the R1 relay close. When thus connected, the current direction in the rotor winding shifts 180°; hence, the relative polarity position between the rotor and stator changes, and the rotor rotates through 90° in the reverse direction.

As the rotor turns, contacts 1 and 2 of the V2 microswitch open; the +27-volt potential is taken off D1, and, hence, off the TsD-32TK unit until contacts 3 and 4 of V2 close.

Thus, channel selection of the waveguide switch is assured with the help of the servo when changing the set's mode of operation.

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

50X1-HUM

[redacted]

Chapter Six

TsD-25TK SYNCHRONIZATION AND SUPRESSOR UNIT

Section 1. General Characteristics of the Unit

The TsD-25TK unit is designed to:

1. Form pulses for synchronizing the operation of all units of the radar;
2. Protect the radar from random pulse noise;
3. Protect the radar from regular pulse noise appearing during the second period of operation of the radar;
4. Select reflected pulses on the basis of duration;
5. Receive the integrated signals of the target.

Section 2. Basic Technical Data

The following pulses are received by the TsD-25TK unit:

1. Target video pulses (noise) from TsD-33 receiver, with amplitude of 10 ± 2v and pulse repetition rate of T9 pps.
2. Artificial target blip in the "noise" mode from the TsD-26TK unit, with amplitude of 35 ± 5v and pulse repetition rate of T9 pps.

The following pulses are fed from the TsD-25TK unit:

1. Integrated target pulse to the TsD-36 unit, with pulse repetition rate of T9 pps and amplitude of 25-40v;
2. Sync pulses to TsD-36 and TsD-33 units (wobbulation), with pulse repetition rate of T9 pps in the scanning mode and T19 pps in the aiming mode and amplitude of 35-70v;
3. Sync pulses to TsD-37, TsD-46, and TsD-26TK units (in "noise" mode) with pulse repetition rate of T9 pps in the scanning mode and T19 pps in the aiming mode and amplitude of 50 ± 10v.
4. Trigger pulse for the intensity pulse-forming circuit (in aiming mode) to TsD-46 sweep unit, with pulse repetition rate of T9 pps in scanning mode and T19 pps in the aiming mode, amplitude of 45 ±10v, and delay of the leading edge of the pulse from the master blocking oscillator of 8.5-20 usec.
5. Trigger pulses of the TsD-33 ShARU (AGS) unit, with pulse repetition rate of T9 pps in the scanning mode and T19 pps in the aiming mode, amplitude of 60-80v, delay relative to the sync pulse in the scanning mode and aiming mode, and wobbulation of 50 ± 25 usec;
6. Pulses of the master blocking oscillator to the TsD-48 unit, with pulse repetition rate of T9 pps in the scanning mode and T19 pps in the aiming mode, amplitude not less than 30v, and duration of 8.5-20 usec.

S-E-C-R-E-T

[redacted]

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

The unit is designed for operation with an ultrasonic delay line (UZLZ).

Power for the unit is from the following sources: 115v ± 4% AC circuit, 600-900 cps, with current not greater than 0.7 amp; a stabilized DC current, +250 ± 2v, with current not greater than 0.065 amp; a stabilized DC current, ±150 ± 2v, with current not greater than 0.065 amp; a stabilized DC current, -250 ± 2v, with current not greater than 0.02 amp; a +27v DC current, with current not greater than 0.13 amp.

Section 3. Description of the Circuit of the Unit

The main circuit of the unit is shown in Fig. 16 (see diagram book) and consists of four basic circuits:

1. synchronization circuit, forming trigger pulses for the TBD-36, TBD-37, TBD-46, and TBD-26TK units and the blanking pulse for the PD-33 I-F amplifier;
2. wide gate width circuit;
3. circuit for random noise suppression and target pulse integration;
4. suppressor circuit for regular noise appearing during the second period of operation of the radar.

In addition, there are auxiliary circuits in the unit:

5. ARU (automatic frequency control) circuit for UPCh-10 I-F amplifier;
6. ShARU (automatic gain stabilization) pulse-forming circuit.

1. Synchronization circuit consists of:
   a) L1 master blocking oscillator;
   b) L4-3 and L4-4 10 mc modulator and oscillator ;
   c) UZLZ ultrasonic delay line;
   d) 10-mc I-F amplifier (UPCh-10);
   e) sync pulse blocking oscillator (left half of L11);
   f) wobbulator (D14, D15, L3-7 - L3-9);
   g) L12 wobbulated pulse blocking oscillator;
   h) delayed pulse blocking oscillator (right half of L13).

The basic stage in the synchronization circuit is the L1 master blocking oscillator. During operation with the ultrasonic delay line the blocking oscillator transfers to the self-sychronization mode and its repetition period is set by the delay time of the delay line. A negative pulse from the L1 master blocking oscillator is sent to the L4-3 modulator, which triggers the L4-4 oscillator. The oscillator produces pulses of ultrasonic frequency within the width of a pulse of the master blocking oscillator. The high-frequency pulses are sent from the oscillator to the ultrasonic delay line, where they are delayed and sent to the UPCh-10 (L5-1 - L5-6). In the UPCh-10 the signals are amplified and detected and sent through the video amplifier and cathode follower to the

buffer grid of the master blocking oscillator, triggering the latter. Thus, the completed delay circuit is formed: master blocking oscillator-modulator - oscillator - ultrasonic delay line - UPCh-10 - master blocking oscillator.

In this case the master blocking oscillator operates in the self-synchronization mode and its repetition period is equal to the delay time of the ultrasonic delay line (UZLZ) - 1/T9 usec.

In the aiming mode a +27v command is sent to the 42R5-1 relay for changing the repetition rate of the masterblocking oscillator. During the operation of the 42R5-1 relay a plate voltage is supplied by the two stages of the UPCh-10. As a result of this, the delay circuit: master blocking oscillator - modulator - oscillator - UZLZ - UPCh-10 is broken. In addition, during the operation of the R1 relay an impact excitation circuit - previously incompletely shorted - is cut in to the circuit of the master blocking oscillator. Thus, the repetition period of the master blocking oscillator in the aiming mode is no longer set by the delay time of the UZLZ but is stabilized by the impact excitation circuit and is equal to 1/T19 usec.

A negative peak from the master blocking oscillator, coinciding with the trailing edge of the blocking pulse, triggers the sync pulse to blocking oscillator (left half of L11), sending positive pulses which trigger the intensity pulse-forming circuit (in the aiming mode) in the TBD-46 unit. Negative pulses from the plate load of the master blocking oscillator are used to trigger the commutator circuit of the wobbulator and dewobbulator. Positive pulses from the cathode load are used for gating the automatic gain control (ARU) of the UPCh-10, the coincidence circuit, and the circuit for the video amplification of the dewobbulated pulses; they are monitored in the TBD-48 unit. Positive pulses from the sync pulse to blocking oscillator are sent to the wobbulator (D14, D15, L3-7 - L3-9), from which the wobbulated pulses trigger the L12 blocking oscillator.

The wobbulated pulses from the L12 blocking oscillator trigger the TBD-36 unit and blank out the TBD-33 receiver of the I-F amplifier (UPCh).

The dewobbulated pulses t_o, held in the delay line of the wobbulator (L3-7 - L3-9), trigger the sync pulse blocking oscillator (right half of L13), from which sync pulses trigger units TBD-37, TBD-46, and TBD-26TK (in the "noise" mode).

2. Wide Gate Width Circuit

The wide gate width circuit consists of:
a) limiter (left half of L3) and video amplifier (right half of L3),
b) L14 pulse duration selector.

The signals reflected from the target pass from the PD-33 receiver to the limiter (left half of L3), the load of which is the L3-4 delay line, grounded at the end. At the output of this equipment appear two pulses of equal duration, with opposite polarity, and delayed relative to each other. The amount of delay is determined by the duration of the incoming pulse. The positive pulse of this pair passes immediately to the L14 duration selector circuit, and the negative pulse is held up by the L3-5 and L3-10 delay lines and then also passes to the L14 duration selector circuit through the video amplifier (right half of L3). Signals appear at the output of the selector only in the event that both pulses coincide in time. The parameters of the limiter, video amplifier, and duration selector are selected in such a way that a pulse will appear at the output of the selector only when the duration of the incoming pulse is not greater than 2.5 usec. When the "Passive Noise Suppression" toggle switch is placed in the "Higher" position, a +27v is fed to the 25R3 relay. The operation of this relay disconnects the pulse width gate. Target pulses of any duration will appear on the indicator scope for a range corresponding to the trailing edge of the target pulse.

3. Circuit for Random Noise Suppression and Target Pulse Integration

The circuit for random noise suppression and target pulse integration consists of:

a) dewobbulator (D6, D7, delay lines L3-1 - L3-3);
b) L4 video amplifier of dewobbulated pulses;
c) video amplifiers L4-1 and L4-2, modulator L4-3, oscillator L4-4 of the 4PZ-S component;
d) UZLZ ultrasonic delay line;
e) UPCh-10 I-F amplifier;
f) L5 coincidence stage;
g) video amplifier and L6 cathode follower;
h) integrated pulse cathode follower (right half of L11).

The main stage of the random noise suppression circuit is the L5 coincidence stage, whose tube conducts only when two signals coincide on its grids. Video pulses and noise from the PD-33 receiver, selected on the basis of duration, pass through the dewobbulator to the L4 dewobbulated pulse video amplifier. From the video amplifier the pulses and noise pass to the coincidence stage and, at the same time, to the delay circuit: L4-2 video amplifier, L4-3 modulator, L4-4 oscillator, UZLZ ultrasonic delay line, and UPCh-10 I-F amplifier.

The pulses, delayed in the UZLZ for the duration of the repetition period, pass to the coincidence stage. In the coincidence circuit the first target pulse, delayed in the UZLZ for the duration of the repetition period, coincides in time with the second non-delayed pulse, coming straight to the coincidence circuit. As a result, the target signals, which are amplified by the video amplifier in the left half of

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

L6, are sent by the coincidence circuit to the output and then to the PD-36 unit through the cathode followers (right halves of L6 and L11) only at the instant of coincidence of the pulses.

To compensate for loss in sensitivity in the coincidence stage a positive feedback circuit is introduced. Pulses passing through the coincidence stage are sent to the L4-1 video amplifier of the 4PZ-S component, where they are added to the direct, non-delayed pulses: i.e., cumulative addition of the signal takes place from pulse to pulse - the effect of integration.

Coincidence of a direct and delayed pulse does not occur in the coincidence circuit when random noise enters the unit, since random noise has a different repetition rate from that of the radar. Consequently, random noise does not pass through the coincidence circuit and does not reach the PD-36 unit.

4. Circuit for Suppression of Regular Noise Occurring During the Second Period of Operation of the Radar

The PD-25TK unit includes circuits designed to protect the radar from regular pulse noise occurring during the second period of operation of the radar. These are pulses reflected from the ground and local objects having the same repetition period as the target pulses but arriving during the second period of operation of the radar, due to the greater distance. To protect the radar from this regular noise, wobbulator and dewobbulator circuits are introduced which use the same channel as that used to suppress random noise.

The wobbulator and dewobbulator are controlled by the pulses which enter the wobbulator and dewobbulator circuits from the commutator in opposite phase. Sync pulses from the sync pulse to blocking oscillator (left half of L11) pass to the wobbulator. The wobbulated pulses from the wobbulator trigger the L12 wobbulated pulse blocking oscillator, generating pulses which trigger the PD-36 unit and then the Pd-32Tk transmitter.

Wobbulated target pulses, selected on the basis of duration, are sent from the receiver to the dewobbulator. In the dewobbulator the pulse repetition period is dewobbulated: i.e., the sync pulse repetition period of 1/T9 usec is reestablished. The repetition period of regular pulse noise appearing during the second period of operation of the radar is not reestablished in the dewobblulator because of the variation in phase of the switching voltage in the dewobbulator. As a result, target pulses at the output of the dewobbulator will be synchronized and have a repetition period of 1/T9 usec, while regular pulse noise appearing during the second period of operation of the radar is unsynchronized and will not pass through the coincidence circuit like any random noise.

5. UPCh-10 Automatic Gain Control Circuit

The UPCh-10 automatic gain control (L2) is designed to maintain a constant transmission factor in the integration channel during fluctuations in the power voltage, temperature, and other operating conditions of the TSD-25Tk unit and the UZLZ ultrasonic delay line.

The automatic gain control operates only with sync pulses from the master blocking oscillator. When a sync pulse arrives at the input of the L2 circuit and is aligned in time with the gating pulse of the L1 master blocking oscillator, a negative DC voltage is fed from the output of the AGC circuit which is used to control the amplification of the first two stages of the UPCh-10.

During fluctuations in the amplitude of the pulses from the UPCh-10 the negative DC voltage at the output of the automatic gain control circuit varies. As a result of this, the transmission factor of the UPCh-10 varies and thus assures a constant amplitude of the pulses at the output of the UPCh-10.

6. ShARU Pulse-Forming Circuit

This circuit includes the following stages:
a) delay phantastron (L7 and left half of L8);
b) ShARU pulse blocking oscillator (right half of L8);
c) ShARU cathode pulse repeater (left half of L13).

The L7 phantastron is triggered by positive pulses from the blocking oscillator of sync pulses $t_o + 5$ (right half of L13). The delay phantastron operates in two modes which are determined by the characteristics of the ShARU circuit.

In the scanning and aiming modes the ShARU pulse blocking oscillator (right half of L8) is triggered by the differentiated trailing edge of the pulse from the phantastron. ShARU pulses from the blocking oscillator pass through the cathode follower (left half of L13) and trigger the ShARU circuit in the TSD-33 unit.

When the ShARU is gated, the radar is protected from overloading of the receiver with ground pulses by wobbulating the ShARU pulses.

To prevent triggering of the master blocking oscillator by noises occurring in the noise zone of the ShARU, pulses from the ShARU are sent to the L14 pulse width discriminator, blanking it during the operation of the ShARU.

Section 5. Construction of the Unit .

Physically, the TED-25TK consists of the following elements:

a) chassis;
b) horizontal panel;
c) forward panel

The chassis connects all components of the unit and on its after side are control pins for securing the unit in its cradle.

The unit is locked in its cradle at two points. On the forward panel are located:

a) socket Sh25;
b) coaxial sockets F5 and F8 and high-frequency cables from various components;
c) monitoring jacks G1 - G12;
d) control resistor R30 "amplification".

On the horizontal panel are located:

a) electron tubes L1 - L14;
b) UPCh-10 component, housed in a separate frame, which is connected to the unit by means of socket Sh2;
c) 4PZ-S driver component, housed in a separate frame, which is connected to the unit by means of socket Sh1;
d) transformers Tr1 - Tr6;
e) delay lines Lz-1 - Lz-7 - Lz-9, Lz-10;
f) potentiometer for regulating bias on control grid of R60 coincidence circuit;
g) L1 inductance coil.

Under the horizontal panel are located:

a) wiring and related elements;
b) delay line Lz-6;
c) Tr7 pulse transformer;
d) potentiometer for regulating bias on suppressor grid of "R54" coincidence circuit;
e) relays R1 and R2.

The weight of the unit (without the UZLZ) is not more than 5.4 kg.
The dimensions of the unit are 194 x 105 x 376 mm.

50X1-HUM

Chapter Seven

TsD-32TK RECEIVER-TRANSMITTER UNIT

Section 1. General Characteristics of the Unit

The TsD-32TK receiver-transmitter unit does the following:

a) generates powerful radio-frequency pulses of short duration;

b) converts reflected target pulses into I-F pulses and preamplifies them;

c) converts pulses in the klystron automatic frequency control (APChK) channel generated by the magnetron into I-F pulses and preamplifies them;

d) automatically fine tunes the local oscillator in the region determined by the points at which the power of the klystron is equal to half of the maximum.

The unit can be divided into two basic components: transmitting component and high-frequency component, depending on the function.

A. The transmitting component consists of a sub-modulator, modulator, magnetron, and rectifier for supplying the sub-modulator and modulator.

The sub-modulator forms pulses of rectangular form, ensuring the necessary duration of a high-frequency pulse.

The modulator amplifies the pulses of the sub-modulator and triggers the magnetron, generating high-frequency pulse signals.

B. The high-frequency component consists of a main waveguide, balanced mixer of the PUPCh (I-F preamplifier), local oscillator with APChK mixer, PUPCh circuit, and APChK (klystron automatic frequency control) circuit.

C. The high-frequency component of the unit transmits and receives high-frequency signals, converts them into I-F signals, and maintains a constant intermediate frequency.

The weight of the unit is 34 kg.
Current required:

115v circuit, 400 cps, not more than 5 amp;
115v circuit, 600-900 cps, not more than 1 amp;
+27v circuit, not more than 6.1 amp.

A schematic diagram of the unit is shown in Fig. 17 (see diagram book)

S-E-C-R-E-T

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

Section 2. Description of Unit Ciruitry

A. Transmitting Section

Positive snychronizing pulses with an amplitude of 40-60 v flow to an amplifier comprised of the left half of tube L1-1. The amplified pulse activates submodulator which is assembled according to the circuit for a blocking oscillator on power-beam tetrode, L1-4. Relay R1-2 in the submodulator functions in the scanning mode and connects capacitors C1-16 and C1-18 to produce the h-f duration Ts. In the aiming mode capacitor C1-6 is switched in to form Ts1.

The right half of tube L1-1 is a restorer diode which is used to ensure a sharp drop of blocking oscillator pulse.

Blocking oscillator pulses flow to the modulator from the submodulator. Modulator functions as a circuit with a storage capacitor. The high-voltage rectifier capacitors C2-1 and C2-2, operating as a full-wave circuit, are used as storage capacitance. The rectifier charges the storage capacitor.. Capacitor C2-2 is charged through a special charging circuit which also includes the magnetron-current measuring circuit.

Pulses, formed by the blocking oscillator, open the modulator upon reaching the modulator tubes. A power pulse is formed which flows to the magnetron. Magnetron preheating is performed by Tr2-3 filament transformer which is switched in at the same time high voltage is switched in. This switching is accomplished via relay R2-1 whose winding is supplied with +27 v when toggle switch ("VKL. vysokogo") on the TsD-41UTPM panel is turned on. Then, 115 v at 400 cps flows from magnetron filament transformer Tr2-3 to high-voltage transformer Tr2-1.

Blocking-oscillator-tube plate voltage (+1450 v) comes from a rectifier which uses thyratrons L1-3 and L1-5 in a full-wave circuit. All remaining voltage flows from the rectifier voltage divider at -900 v. This rectifier uses L1-2 thyratron in a single half-wave circuit and produces power for the arrester circuit of the delay line in the h-f section of the unit.

Using toggle switch PK-1 the primary windings of transformers Tr2-1 and Tr2-3 are switched from the wobbulating frequency power supply to a fixed frequency supply.

B. Radio-Frequency Section

S-E-C-R-E-T

[redacted]

The following components are found in the section:

1. Main waveguide.
2. Signal channel balancing mixer.
3. Heterodyne with APChk mixer.
4. i-f preamplifier PUPCh.
5. Klystron frequency fast tuning component APChK.

A power r-f pulse, gererated by the magnetron, is transmitted to main waveguide consisting of a waveguide slot bridge, ferrite circulator and double-tt at the unit output. Main waveguide protects magnetron from load fluctuations by maintaining constant frequency to magnetron. Received echos from the target and r-f pulse signals of frequency fe-fm proceed to unit input and are directed through arrester and double-tee to crystal detectors D1 and D2 of signal channel balancing mixer. Variable attenuator A1 and double tee transmit a continuous r-f signal from heterodyne to balancing mixer via the coaxial waveguide junction.

Intermediate-frequency pulses flow to input circuit of i-f preamplifier PUPCh from balancing mixer output. The i-f pulses, amplified by three stages of PUPCh (Lz-1, Lz-2 and Lz-3) are sent via r-f cable F1 to i-f amplifier UPCh in unit TsD-33.

Radio-frequency heterodyne L1 operates signal channel and APChK. Separation of r-f heterodyne signal is done by the double-tee. From one branch the r-f signal is directed to mixer signal through coaxial waveguide junction. The r-f signal from heterodyne is transmitted to APChK mixer-crystal detector D3--from second branch through variable attentuator A2 and directional coupler.

Radio-frequency pulse signal from magnetron of main waveguide is also transmitted to APChK mixer through variable attentuator A3, coaxial waveguide junction and directional coupler. Intermediate-frequency pulses are transmitted to input circuit of APChK component. In the APChK component i-f pulses are amplified by two UPCh stages, L4-1 and L4-2 and flow to frequency detector L4-3 where videopulses from the detector are amplified by vidcoamplifier L4-4 and go to pulse detector comprising the left half of tube L4-6. The dc voltage, split at pulse detector, flows to transitron oscillator L4-5.

Transitron oscillator can operate in saw-toothed voltage mode("search" mode) and in a mode of dc amplification (APChK mode). Transitron oscillator operates in the "Search" mode when difference of magnetron and klystron signal frequencies is not equal to intermediate frequency and when there is no signal from magnetron (transmitter turned off or disconnected). When magnetron and klystron frequency difference is close or equal to IF the

S-E-C-R-E-T

[redacted]

50X1-HUM

[redacted]

transitron oscillator operates in dc amplification mode. Amplification of the stage in this instance depends on magnitude of negative voltage applied to the grid which, in turn, depends on amplitude of pulses from videoamplifier L4-4 and increases with increasing frequency difference. Sawtoothed voltage (in "Search" mode) or dc voltage (in APChK mode) is transmitted from transitron oscillator output to cathode follower (half of tube L4-6). Control voltage is sent from cathode follower to klystron reflector plate K-27 for fine frequency tuning.

Klystron frequency tuning can also de done manually from panel TsD-48. Here, transitron oscillator, using relay R4-1, is disconnected from cathode follower. Voltage to klystron reflector plate is transmitted from cathode follower.

Section 3. Description of the Circuit

A. Transmitting Section

1. Submodulator

The submodulator consists of an amplifier using left half of tube L1-1 (6N1P-V), blocking oscillator with external pulse excitation on a full-wave beam tetrode L1-4 (GI-30) and a stage which expedites restoration of circuit to right half of tube L1-1 (6N1P-V).

Synchronizing pulses with an amplitude of 40-60 v and period of 0.4-0.2 microsec from unit TsD-36 flow through capacitor C1-1 to amplifier grid (left half of tube L1-1). Pulse transformer Tr1-1 serves as amplifier load. Grid leak R1-1 is connected in the tube grid circuit. Initial amplifier mode is determined by the load developed by automatic bias circuit (RI-3 and CI-3) connected into tube cathode circuit.

Synchronizing pulses flowing to grid can be monitored with jack G1-1. Positive pulse from secondary winding of pulse transformer goes to blocking oscillator trigger.

Amplifier power is a rectified load of -250 v which is taken from resistors R1-6 and R1-5 of divider R1-2, and resistors R1-32, R1-6 and R1-5. The above-mentioned divider is a rectifier load of "-900 v" in tube L1-2.

Blocking oscillator L1-4 forms pulses of given length which are controlled by modulator.

[redacted]

50X1-HUM

Relay Rl-2 is connected in scan mode and switches in pulse--forming capacitors Cl-16 and Cl-18 between screen and control grids of blocking oscillator Ll-4. In the aiming mode (when "Zakhvat" lock-on) button is pressed relay Rl-2 is disconnected and capacitor Cl-6 switches to blocking oscillator circuit.

Both halves of blocking oscillator tube are connected in parallel. Pulse transformer Trl-2 provides blocking oscillator load. Until synchronizing pulse reaches blocking oscillator, its tube control grid is cut off by a negative voltage of -11 to -15 v, taken from resistor Rl-5.

Upon triggering blocking oscillator tube with amplifier pulses, plate current starts to rise in tube plate circuit. A strong feedback between transformer plate and grid windings causes rise of positive voltage in tube grid and this, in turn, leads to an even larger increase of plate current

The process of plate current rise due to increase of positive potential at the grid occurs in an avalanche-like manner. Steepness of pulse edge growth is determined exclusively in this case by magnitude of spurious parameters--inductance dissipation and distributed capacitance of transformer windings.

Since these blocking oscillator parameters are very small, the growth of .. pulse edge when triggering oscillator tube occurs quite rapidly. Further increase in plate current due to saturation is retarded, voltage rise at the tube grid is diminished, and equilibrium soon established in the circuit. This equilibrium corresponds to the formation of the flat section of the pulse.

With voltage decrease at the tube grid, due to strong feedback, a rapid decrease of tube plate current will take place. This process also occurs in an "avalanching" manner as a result of which the tube is quickly cut off. The next amplified synchronizing pulse will open blocking oscillator tube only after pulse-forming capacitor is discharged. Accelerated discharge of forming capacitor is called restoration of the circuit, accomplished by right half of tube Ll-1, which is connected with a diode. When connecting or switching in tubes, discharge of capacitors Cl-16, Cl-18 or Cl-6 is shunted by open diode Dl-1 and small resistor Rl-9.

For purposes of suppressing possible parasitic oscillations to plate and grid circuit of blocking oscillator, antiparasitc resistors Rl-16, Rl-34 and Rl-22 are connected respectively. Plate voltage to blocking oscillator is 1,450 v. Pulse amplitude to plate winding of transformer is 900 v. Positive pulse (350 v) is taken from output windings 7 and 8 of blocking oscillator transformer and transmitted to control grids of modulator

S-E-C-R-E-T

[redacted]

tubes. To suppress possible parasitic oscillations in Trl-2 transformer windings, the latter are shunted with resistors Rl-12, Rl-13, Rl-19, Rl-23 and Rl-28.

To check operating status of submodulator there are special monitoring jacks to monitor following:

1) Gl-1--synchronizing pulse from unit TsD-36;

2) Gl-2--blocking oscillator triggering pulse;

3) Gl-3--pulse going to unit TsD-42

From jack Gl-3 the positive pulse going to unit TsD-42 is taken. This pulse is called "Start-Pulse" because it coincides in time with the r-f pulse being emitted by the magnetron.

2. Modulator and magnetron oscillator

The transmitter modulator is comprised of two-beam tetrodes Ll-6 and Ll-7 connected in parallel with partial discharge of stored capacitance.

High-voltage filter capacitors C2-1 and C2-2 are utilized as storage capacitor. Between pulses, modulator tubes are blocked because there is a bias voltage of -280 to -250 v at their screen and control grids developed by means of grid currents, circuits consisting of resistors Rl-23, Rl-12 and Rl-17 and windings of relays Rl-1 and Cl-8.

Between pulses the storage capacitors C2-1 and C2-2 are charged from high-voltage rectifier made up of kenotrons L2-1 and L2-2 which function as a full-wave circuit (component 2). Capacitor C2-2 is charged via the circuit consisting of resistors R2-1, R2-2 and R2-3. Resistors R2-2 and R2-3, shunted with capacitor C2-3, are disigned to measure magnetron current. Total resistance of R2-2 and R3-2 is selected so that the voltage from these resistors is numerically equal to magnetron pulse current, expressed in amperes.

When triggering pulses reach the modulator tube grids the capacitor is discharged to the magnetron via open modulator tubes whose resistance drops to 50 ohm. A negative pulse with duration T_{ς} or $T_{\varsigma 1}$ microsec, corresponding to blocking oscillator pulse duration, is formed at the magnetron cathode at this time.

After blocking oscillator pulse completion the circuit must be rapidly restored (must quickly discharge parasitic capacitances). Capacitance of storage capacitors is calculated so that during time of pulse there would be no noted decrease of voltage being transmitted to magnetron.

S-E-C-R-E-T

[redacted]

Simultaneously, these same capacitors, being filters, ensure flattening of voltage pulses at rectifier output. When positive submodulator pulse terminates, the modulator tubes are blocked and process of boosting storage capacitor C2-1 and C2-2 charge up to a voltage close to power source voltage is initiated.

To suppress antiparasitic oscillations in the modulator in its control grid circuits, antiparasitic resistors R1-29 and R1-31 are switched in. Transformer Tr2-3 is used to preheat magnetron. A voltage of 115 v (400 cps) is transmitted through the normally closed contacts of relay R2-1 to primary winding.

Upon triggering relay R2-1 a load of 115 v is switched out of magnetron filament transformer Tr2-3 and flows to primary winding of high-voltage transformer Tr2-1 thus starting high-frequency oscillator. A packaged magnetron L2 is used in the transmitting unit as a high-frequency oscillator.

Magnetron current is regulated by switching branches of the high-voltage transformer primary winding. The two-way magnetron current switch is located under unit cover. Relay R2-1 is cut in when load to it is 27, passing into the unit after triggering the time relay which is located in unit TsD-42 and after switching on toggle switch "Vys. vkl." on the panel of TsD-41UTPM. A circuit of /27 v from TsD-41UTPM panel is closed via relay R1-1 contacts. These contacts can be closed only when there is submodulator tube current. This prohibits a high-voltage influx if no synchronizing pulses are present.

To ensure safe working conditions during unit repair the high voltage is turned off for cover removal.

A load of 115 v (400 cps) is transmitted to primary winding of transformer Tr1-3 through the normally closed relay R1. Upon lowering unit pressure to 0.8 atm the contacts of pressure transducer RD-1 are closed and the current to ground is transmitted to relay R1 winding. The relay is triggered and relay contacts opened after de-energizing a load of 115v (at 400 cps) from primary winding of transformer Tr1-3. Thus plate and grid circuits of amplifier and submodulator tubes are de-energized and possible influx of high voltage is averted. In this way protection of possible breakdowns at reduced pressure is achieved.

3. Rectifier

Submodulator receives plate power supply (/1,450 v) from the rectifier which comprises a full-wave circuit with non-filament thyratrons L1-3 and L1-5.

S-E-C-R-E-T

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

50X1-HUM

[redacted]

A negative load of 900 v flows from rectifier composed as a single half-wave rectifier with non-filament thyratron L1-2. A voltage divider is connected to rectifier output. The voltage divider consists of resistors R1-2, R1-32, R1-6 and R1-5.

S-E-C-R-E-T

[redacted]

50X1-HUM

B. Radiofrequency Section

1. Main Waveguide

The main waveguide is intended to facilitate transmitting and receiving operations from the same antenna.

Transmitting work is provided with protection of crystal detectors D1 and D2 of the balance mixer from burning out and the receiving channel input of the PUPCh is protected from the action of powerful magnetron impulse during RF signal radiation.

Receiving work is insured of rf signals reflected from the target entering the input of the balance mixer with least losses in the magnetron oscillator circuit.

The main waveguide consists of an ATR tube, a waveguide slit bridge, ferrite circulator, double tee, and a limiting attenuator in the APChK system.

The basic property of the ferrite section lies in the fact that on distribution of energy along waveguides in which ferrites are installed along a narrow wall, in the presence of a transverse magnetic field the distribution phase constant changes. The change in phase constant depends on the magnitude and direction of the magnetic field, on the direction of energy distribution, and on displacement of the ferrite relative to the axis of symmetry of the waveguide.

As a result of selected dimensions in the ferrite plates, selected magnitudes of the magnetic field and the plate displacement relative to waveguide axis, the wave phase leaving the ferrite section is changed 45° in each channel. Due to a definately selected direction of the external magnetic field and displacement of the ferrite plates relative to the direction of energy distribution, one channel has a phase lag and one channel has an advance.

In this manner phase differences in waves formed as a result of the slit bridge are compensated.

2. Signal Balance Mixer

The signal balance mixer is one of the elements of the receiving channel and it provides high sensitivity. The balance mixer is assembled as a double tee. The crystal detectors D1 and D2 are equally spaced in the arms of the double tee.

[redacted]

To provide for a minimum coefficient of noise in the receiver each crystal is fed an RF output of 0.2-0.6 milliwatts from the local oscillator, which corresponds approximately to 1 $\pm$ 0.2 millamperes detector current.

The detectors are placed in the detector heads assembled in the T-shaped waveguide.

Waveguide dimensions are selected so that the wave resistance will approximate the active crystal resistance, and the reflections caused by the crystals and holders will be compensated by reflections from short-circuited walls placed behind the crystals.

3. Local Oscillator With APChK Mixer

A reflecting klystron is used as a local oscillator L1 of the radio-frequency section of unit TsD-32TK. A potential of $+$300 volts is applied to the klystron resonator in unit TsD-32. The klystron is situated in a special holder. The RF energy of the klystron is fed via a coaxial cable through a round orifice protected with a trap. The waveguide, into which the klystron energy output is fed, is a shoulder H of a double tee (analogous to the signal mixer tee), with which the klystron energy is divided into two channels: a signal channel and the APChK channel. The shoulder of this tee terminates as coaxial-waveguide junction, with which the RF signal enters the signal mixer from the local oscillator through cable No 1.

The coaxial-waveguide junction is a junction from the waveguide to the cable. The central conductor of the cable ends in a pear-shaped terminal and enters the waveguide in the middle of a broad wall perpendicular to its surface. The distance from the short-circuited wall of the junction to the axis of the cable and all dimensions of the pear shape are experimentally chosen from conditions giving maximum signal transmission from the local oscillator to the mixer.

A directional coupler serves to feed the signal from the local oscillator and magnetron to the APChK mixer. The directional coupler consists of two waveguides with a common wall. This wall has four coupling openings.

4. Intermediate Frequency Preamplifier

The intermediate frequency preamplifier (PUPCh) is a part of the intermediate frequency amplifier, and is made up in a separate unit, the layout taking into account the given sensitivity. The PUPCh contains an input circuit, which is a coupling element with the balance mixer, and an

S-E-C-R-E-T

[redacted]

amplifier made up of tubes Lz-1, Lz-2, Lz-3. The input circuit consists of the input elements L3-5, C3-7, L3-6, C3-8, L3-7, L3-8, C3-10.

The input circuit is on the balance principle and is designed to provide a minimum noise coefficient. The input elements consist of transformers with four windings, the primary windings L3-5 and L3-6 are connected each to its secondary winding, and the secondary windings L3-7 and L3-8 meet each other. This kind of winding provides for combining of counterphase voltages of the useful signal and mutual elimination of inphase noise voltages. The degree of noise suppression depends on the layout symmetry and is of the order of 15-20 db. The quality factor of the secondary windings and the coefficient of transformation of the circuit is chosen from conditions which provide a minimum noise coefficient. The coefficient of transformation is 2-3.

Each pair of windings L3-5, L3-6, L3-7, L3-8 is tuned to intermediate frequency with trimmers C-3-7, C3-8, C3-10.

The PUPCh consists of three amplifier stages. The first two stages L3-1 and L3-2 have a triode hook-up in a "cascade" system (first with grounded cathode, second with grounded grid), L3-9 -- plate choke, R3-1 -- automatic shift, C3-12 -- filter capacitance of stage L3-1, and R3-4 -- bias for tube L3-2. The resistance R3-5 serves as the load for stage L3-2.

To increase amplification stability in the second stage, an interelectrode plate-cathode capacitance for tube L3-2 is utilized. The stage is neutralized with coil L3-10 tubed with plate-cathode capacitance of tube L3-2 in resonance for frequency [sentence incomplete].

The third amplification stage L3-3 is used to provide necessary amplification for a given band. This stage is connected in a pentode hookup. Here R3-7 is the bias resistance and C3-20 is the filter capacitor.

Because the PUPCh operates on a low ohm load resistance 33R1-51 ohms, the matching connecting cable F1 is connected to the element of the third stage in series with the tuned inductance L3-15. The required attenuation of the output element is secured by matching resistance R3-11 and resistance 33R1-51 ohms. The amplification factor for given band in a selected three-stage amplifier is best secured by using detuned circuits.

The plate circuits of the PUPCh has filters L3-2, C3-9, L3-3, C3-1, L3-8, C3-16, which eliminate spurious coupling between the PUPCh stages. In the filiment circuit of the tube, filters are connected to the inductances and capacitances C3-18, L3-13, C3-15, L3-11, C3-1. The direct current component of crystal I of the converter passes through filters L3-2, C3-2, L3-1, C3-1 and the current from crystal II passes through filters L3-3, C3-5, L3-4, C3-6 to connector Sh3-1. C3-3, C3-4, C3-13,

C3-17, C3-19 are coupling capacitors.

The power supply to the PUPCh enters through the distributer head from the following power sources:

a) regulated voltage of +150 ±2.0 volts with current consumption to 40 ma.

b) potential of 6.3 volts, with current consumption to 550 ma.

5. Automatic Frequency Control Circuit for the Klystron

The automatic frequency control circuit for the klystron (APChK) is designed for maintaining a nominal intermediate frequency of IF plus or minus 0.3 mc during frequency drifts in the local oscillator or magnetron.

Klystron frequency is automatically regulated by voltage changes in the reflecting electrodes of the klystron so that the frequency differences between the magnetron and the klystron are maintained constant and equal to the intermediate frequency.

The APChK system operates on its own transmitter impulse with tapped portion of the magnetron energy in the mixer chamber of the APChK.

The unit contains:

1. Intermediate frequency amplifier L4-1, L4-2,

2. Frequency detector L4-3,

3. Videoimpulse amplifier L4-4,

4. Impulse detecter, left half of L4-6,

5. Sawtooth voltage generator -- transitron for L4-5,

6. Cathode repeater for right half of L4-6.

The basic technical characteristics provided by the APChK circuit are presented in the basic technical data on the TsD-32TK section. The operation of the APChK circuit consists of the following.

Radioimpulses from the transmitter enter the APChK mixer through the limiting attenuator. From the mixer intermediate frequency impulses enter the intermediate frequency section of the APCh through the RF cable.

The intermediate frequency amplifier is made up of two stages L4-1, L4-2 with resonance single elements L4-3, C4-4, L4-4.

Resistances R4-1 and R4-6 are installed in parallel to elements L4-3 and L4-5 and are intended for broadening the transmission band of the intermediate frequency amplifier. Element L4-5 is connected with the frequency detector element, made up of tube L4-3. Resistance R4-1 serves as frequency detector load for the left diode triode in which the plate is connected with the grid, and R4-10 serves as frequency detector for the right diode. The load resistances are hooked up in such a way that the voltage, taken at the amplifier, will deepen on the degree of deviation from its nominal value.

The controlling circuit is used for searching local oscillator frequency and constant voltage output to the klystron reflector, with which frequency drifts of the local oscillator or transmitter magnetron in the automatic tuning mode are compensated. The controlling circuit consists of a sawtooth voltage genrator L4-5 in a transitron circuit, an impulse detector, and a cathode repeater.

The dependence of the plate and screen current on the voltage on the pentode grid is utilized in the transitron oscillator. When the negative voltage on the pentode grid increases, the plate current begins to fall and the screen current increases. When the negative voltage on the pentode grid decreases, the plate increases and the screen current drops. Let us assume that at some given moment the voltage on the pentode grid is positive in respect to its own cathode. The tube is open and the plate current is flowing. When this happens capacitor C4-19 rapidly discharges through the tube. Because the plate current passes through resistor R4-20, the plate-cathode voltage on the tube drops, which after a certain moment of time results in a drop in the plate current. A drop in plate current causes an increase in screen current. An increase in screen current furthur lowers the voltage on the screen grid; this drop in voltage through capacitor C4-20 is transmitted to the pentode grid, which even furthur decreases the plate current. The process of decreasing the plate current will continue to full completion, and the tube is blacked out in plate current, since a negative voltage is created on the pentode grid. Capacitor C4-19 begins to be charged and capacitor C4-20 is discharged through the screen grid-cathode interval in tube L4-5 and resistors R4-19 and R4-24.

When capacitor C4-20 discharges, the voltage on the pentode grid decreases, and the moment of appearance of plate current begins again. When this happens the screen grid current drops, and the voltage on it begins to increase. The voltage increase on the screen grid is transmitted to the pentode and accelerates the increase in plate current. Thus, with a plate load on transitron R4-20, the voltage will change according to the

sawtooth law. This sawtooth voltage is transmitted through resistor R4-22 and the normally closed contacts of relay R4-1 to the cathode repeater grid. With a load on the cathode repeater R4-26, the changing negative voltage is transmitted to the negative electrode of the klystron, where corresponding changes in frequency take place. When a difference frequency appears which exceeds the tuning point of 29.6 mc, a negative pulse appears at the frequency detector load. This pulse, amplified by amplifier L4-4, is transmitted with positive polarity to the plate of the impulse detector on the left half of L4-6. The diode opens and the direct current component, flowing along load resistor P4-17, creates negative voltage which is applied to the grid of transitron oscillator L4-5. When this happens, searching on the transitron oscillator stops and tube L4-5 starts to operate as a direct-current amplifier.

The greater the intermediate frequency differs from the tuning frequency of the frequency detector element, the more the positive impulse enters the impulse detector and greater the current flow across resistor R4-17, creating greater negative voltage on the grid of tube L4-5. The current in tube L4-5 decreases and the negative voltage on load R4-20 drops.

Assume that the intermediate frequency is about equal to Frfl mc. At the load of the frequency detector, a negative impulse will act finally on the direct current amplifier tube L4-5 in such a manner that at its load R4-20 the negative potential will decrease; this, acting on the reflecting electrode of the klystron, will lower its frequency. Since the klystron is tubed to a lower frequency than the magnetron in the TsD-32TK section, this leads to a decrease in the difference frequency.

The APChK mode is the operating mode in the TsD-32TK section. The APChK unit is connected with the mixer by coaxial cable, terminating in a high frequency plug connector.

The unit gets power from the power supply box through connector Sh4-1. The following voltages are required to operate the APChK unit: +150 ± 2.0 volts, stabilized; -250 ± 2 volts, stabilized; 6.3 volts ± 5%, 600-900 cycles.

6. Distribution Box

In the distribution box are situated the filament transformer for the tubes in units 3 and 4 Tr5-1 and filters for power and control circuits: L5-1, L5-2, L5-3, L5-4, L5-5, L5-6, L5-7, L5-8, C5-1, C5-2, C5-4, C5-5, C5-6, C5-7, C5-8, C5-9, C5-10, C5-11, C5-12.

Section 4. Construction of the Unit

The frame is divided by a solid partition into two bays: modulator and

S-E-C-R-E-T

radio frequency. The partition has two ports, one for the cathode leads and magnetron heater installed in the radio frequency bay, and one for the electrical assembly. The section cover is closed with a shield having a tube for conducting cooling air to the section. The air consumption is 150 liters/minute. The section is air-tight.

In the modulator bay there are two units: unit (modulator) and unit (high voltage rectifier). In the radio frequency bay are located: pressure sensor, magnetron, magnetron cooling ventilator, power supply box, and all other units on a cast base. All electrical connections are knife connectors. All screws are locked on either with paint or with spring washers.

1. Unit 1 (Modulator)

The modulator is assembled on a light, stamped chassis. The heating elements (tubes) are separated from the other parts as much as possible.

The ventilator is located on the modulator chassis.

Electrical contact with the high voltage rectifier is accomplished with connector Sh1-1 and the plate busbar for tubes L1-6 and L1-7.

2. Unit 2 (High Voltage Rectifier)

It is assembled on a light, stamped chassis. On the chassis are situated filament transformers for magnetron Tr2-3 and the high voltage rectifier tubes Tr2-2 plate transformer Tr2-1, storage capacitors C2-1 and C2-2, charging circuit R2-1, R2-2, and R2-3, current control for magnetron C2-3, and R2-3, and high voltage relay switch R2-1. Electrical connection with the submodulator (unit 1) and the frame is accomplished with connectors Sh2-1 and Sh2-2; with the magnetron -- with two spring contacts.

3. Units 3, 4 (Radio Frequency Part of the Unit)

Structurally, the high frequency part of the unit is assembled in the form of a dismountable frame, to which are fastened all components of the high frequency part (except 5): waveguide components, PUPCh -- component 3 and APChK -- component 4. The waveguide components are structurally three separate components:

1) main waveguide,

2) balance mixer,

3) local oscillator unit.

S-E-C-R-E-T

All components are made of brass waveguides of 10 x 23 mm cross section.

1. The main waveguide consists of a segment of the waveguide terminating in two flanges, one flange being connected with the magnetron flange, the other with the antenna flange. The flanges are connected with lock nuts.

On the narrow wall of the main waveguide is situated the choke flange to which discharger L3 is fastened. The discharger is fastened between the flanges of the main waveguide and the input flange of the balance mixer.

Along the narrow wall of the main waveguide (near the magnetron) is located the limit attenuator, consisting of two parts connected with special flanges. The limit attenuator terminates with a waveguide segment in which is located along the narrow wall the attenuator A3 and a junction to the coaxial cable leading to directional coupler of the local oscillator component.

2. Balance mixer is a double waveguide tee.

The balance mixer is fastened to the PUPCh chassis component. The input element of the PUPCh is soldered to the output leads of the detector heads in such a manner that the PUPCh and the mixer are removed together.

3. The local oscillator component is also a double waveguide tee. The klystron is covered with a cap. The klystron power cable leaves the body of the klystron holder and terminates in a four-way connector.

Waveguide of arms 1 and 2 are directed upward. Waveguide of arm 1 terminates in a junction to cable RK-119, which comes from the mixer. Waveguide of arm 2 is primary waveguide of the directional coupler. The waveguide terminates in a load absorber. Before the directional coupler of the waveguide of arm 2 is situated attenuator A2. The secondary waveguide of the directional coupler terminates in the detector head of the APChK mixer; on the other end of the secondary waveguide is a junction to cable RK-119, leading from the limit attenuator.

4. Component PUPCh is assembled on a separate chassis and is connected with the mixer with connectors (the ground contact is fitted with a spring bushing, and the output contacts of the mixer are soldered to the input element).

In the PUPCh, the stages are constructed in blocks. Each stage is mounted individually to the frame, fastened on the tube panel, and then the stages are installed on the chassis. A cover, enclosing the assembly,

is fastened to the chassis.

An output instrument plug is installed on the PUPCh chassis.

5. The APChK component is assembled on a separate panel. The panel is closed with a cover. On the face panel of the unit there are three jacks (frame, frequency detector output, and output for sawtooth voltage to klystron reflector).

To tune the frequency detector element, an adjusting screw of tuning capacitor C4-12 projects under a slot in the face side of the panel.

A knob of potentiometer R4-30 for establishing the search band on the APChK also projects from the face panel of the unit.

The RF amplifier of the APChK unit is assembled in individual stages. The basic parts of the circuit are mounted on a demountable panel.

6. The distribution box is assembled as an individual component. Inside are located the tube filament transformers for components 3 and 4 (Tr5-1) and the filters in the power supply and monitoring circuits.

Electrical connection between the components and the frame is facilitated with knife connectors. A filter is provided for the TsD-32TK unit, in which is installed potentiometer F.32R -- an installation for limiting the zone of generation of the klystron for preventing the "P" lamp from burning in the frequency search mode.

The filter layout is shown in Fig. 18 (see book of drawings).

S-E-C-R-E-T

Chapter Eight

RECEIVER TsD-33

Section 1. General Description of the Unit

The TsD-33 is designed to function in scanning and aiming modes with a target or with smooth noise interference.

The unit provides for:

a) amplification of the signals of intermediate frequency which are reflected from the target, their detection, and the feed of intensified video-signals in the synchronization and suppression unit TsD-25TK to the antenna-control unit TsD-40TK, to the range unit TsD-37;

b) amplification of noise interference converted to intermediate frequency, detection and feed of amplified interference noises to the noise-interference indicator unit TsD-26TK, to the antenna-control unit TsD-40TK, to the synchronization and suppression unit TsD-25TK;

c) time manipulation of reception and selection of locked-on targets by range;

d) automatic regulation of the amplification of the IF amplifier as to signal reflected from the target;

e) automatic regulation of the amplification of the IF amplifier as to noise interference;

f) automatic regulation of the level of noises of the receiver;

Section 2. Principal Technical Characteristics

1. The unit should provide a signal amplitude up to full limitation:

a) in the channel of the suppressor unit, not less than 27v,

b) in the channel of the range unit, not less then 32v,

c) in the channel of the noise interference indicator, at least 25v,

d) in the channel of the antenna-control unit, not less than 25v.

2. The amplitude of the noises at the receiver output (socket G1) during measurements by VTVM with a scale in effective units -- 5-8 volts.

3. The ARU system provides a signal level at the output of the receiver (socket G1) of 21 plus or minus 2 volts.

4. The amplitude of the signal for the antenna-control channel (socket G3) with signal amplitude at socket G1 of 21 volts - 14-18 volts.

5. Currents required by the circuits of the unit:

a) 115 volts 600-900 cycles - 0.65 ± 0.1

b) +250 volts stab. - not more than 30 ma

c) + 150 v stab. - not more than 60 ma

d) - 25 v stab. - 60 ± 10 ma

Circuit diagram of the unit is given in Fig 19 (see diagram book).

Section 3. Description of the Unit Circuit

The signal of the target or of noise interference, after it has been converted into intermediate frequency and subjected to preliminary amplifying in the PUPCh, goes from the TsD-32TK unit to the input of the IF amplifier.

The IF amplifier has six cascades -- L1 - L6. The signal amplified in the UPCh is detected by the diode detector L7, is amplified by the video-amplifier L8, and from the output of the cathode follower 1 left half L9, it goes: into TsD-25TK unit, through the cathode follower IV left L23, into the TsD-26TK unit, onto the input of the ARU-ShARU systems, to the coincidence stage L20 of the output system into the antenna-control unit TsD-40TK.

From the stage of the load of the cathode follower 1 on left half L9 the signal is fed onto the input of the video amplifier right half L22 with the grounded circuit and then through two series-connected cathode followers II, III (left half L22 and right half L9) to the range unit TsD-37

For the suppression of external noise in the receiver, the UPCh is normally closed, and is opened only by the gates set up by the manipulator of reception. Manipulation of the reception takes place in the first two stages of the IF amplifier.

S-E-C-R-E-T

Depending on the operating mode of the radar, the amplification channel is opened by the following impulses:

a) in the scanning mode -- by wide gate;

b) inthe aiming mode -- by narrow gate;

c) in both modes to provide operation of the ShARU circuit -- by the ShARU gate.

g) in the mode of scanning and aiming with smooth noise interference -- by the ShARU wide gate.

Consequently, noise and reflected signals will occur at the output of receiver only in the indicated gates.

1. Operation of the Receiver in the Scanning Mode

In the scanning mode, the receiver is opened for passage of noises and signals during the time of operation of the wide gate and for the passage of noises in the ShARU gate.

The wide gate and the ShARU gate are created by the manipulator of reception, consisting of a multivibrator-selector L10 and a buffer cascade left half L11. In the mode of generation of the wide gate, the cascade on tube L10 works as a multivibrator and is triggered by impulses of an amplitude of 30-45 volts and a duration of 0.7 plus or minus. 0.3 microseconds from the TsD-36 unit. When operating on ShARU pulses, the cascade on tube L10 operates as a selector (limiter) of ShARU pulses, passing to its output through the buffer amplifier left half L11 from the TsD-25TK unit.

The IF signals and the noises proceed from the TsD-32TK unit to the input of the IF amplifier, are amplified by the IF amplifier in the wide gate and in the ShARU gate, are detected by diode detector L7, are amplified by the L8 video amplifier, and from the output of the cathode follower I (left half of L9) proceed: to the TsD-25TK unit, through the cathode follower IV (left half L23) to the TsD-26TK unit, to the input of the receiver's circuit of automatic regulation for noise.

The system of automatic gain stabilization of the receiver (ShARU system) sustains at the output of the receiver a fixed level of noises with changes in supply voltages, tube aging, and crystal replacement, necessary for normal operation of the TsD-37 range unit, the indicator channel, and the channel for noise interference indication.

Operation of the ShARU system is also provided by the ShARU gate, which proceeds from the TsD-25TK unit to the limiter right half L11.

From the output of the receiver noises proceed to the input of the ShARU coincidence stage L12, controlled by ShARU gate from the output of the limiter right half L11.

Thus, at the output of the coincidence stage there are developed noise impulses only in the ShARU gate, at whose level the gain of the receiver with respect to noise is regulated. Then the noise impulses are amplified by the ShARU video amplifier left half L13, proceed through the noise pulse limitation stage left half L15, and are fed to the ShARU detector right half L13. The pulse noise limiter serves to reduce the effect of pulse noises on the coefficient of amplification of the receiver.

From the load of the ShARU detector, the regulation voltage proceeds to the UPT left half L14, is amplified, and from the output of the cathode follower right half L14 is fed to the control grids of the first, second, third and fourth s of the IF amplifier L1, L2, L3, L4.

Since the amplification of the receiving channel in the scanning mode is determined by the level of the noises in the ShARU gate, provision has been made for effecting some interference suppression in the ShARU system. The ShARU gate, in the scanning mode, is delayed in relation to the impulse of the transmitter, and at these ranges of reflections the signal is considerably weakened. During the time of the action of the ShARU gate, the suppression of ground impulses is effected through wobbulation of the ShARU gate at 50 plus or minus 25 microseconds -- which somewhat reduces the probability of incidence of ground pulses in the ShARU gate. The ShARU system is protected against pulse noise by the pulse-noise limiter, left half L15.

For elimination of possible overload of the receiver from a leaking pulse of the transmitter, the triggering of the multivibrator of the selector is delayed relative to the transmitter triggering pulse and the fifth cascade of the IF amplifier is locked by a positive pulse.

2. Receiver Operation in the Aiming Mode

In the target aiming mode, receiver trigger pulses from the TsD-37 range unit stop triggering the multivibrator selector, which then is fed the narrow gate from the TsD-37 range unit. The multivibrator-selector now operates in the limiting mode. Before target lock-on by the TsD-37 range unit, the narrow gate is shifted in range from T_{np} (start of search) to T_{kp} (end of search).

S-E-C-R-E-T

50X1-HUM

Thus, in the target aiming mode, the receiver is unlocked twice in the ShARU gate time interval and during the narrow gate, which tracks the target for range.

After the range unit locks on target, relays 42R6 and 42R6-1 of the TsD-42 unit operate; this removes the large locking voltages from the ARU, L17, and L18 coincidence stages and the receiver automatic gain control circuit begin to function.

The signal and interference from the receiver output and the two half-gates from the TsD-37 range unit are fed to the coincidence stages. Half-gate I, almost coinciding with the target signal, is then fed to the L18 coincidence stage. Half-gate II, delayed relative to half-gate I, is fed to L17.

Pulse signals from the L18 coincidence stage are detected by the L16 difference detector.

From the detector output, the control voltage is fed to the UPT (dc amplifier) of the ARU (AGC), the right half of L5; to the UPT of ARU-ShARU, the left half of L14; and to the cathode follower, the right half of L14. From the cathode follower load, the control voltage is fed to the control grids of the first four UPCh (AFC) stages.

The time constant of the ARU filter is selected so as not to demodulate the signal by the ARU circuit, i.e., so as not to react to the change in the signal with the T30 scanning rate.

It should be noted that the given ARU circuit is shielded from random and nonsynchronous noise.

Interference shielding of the ARU circuit is accomplished through the use of a time discriminator consisting of the L17 and L18 coincidence stages and the L16 difference detector.

If the interference coincides with the first and second half-gates of the coincidence stages, the pulse signals, produced by the stages, are fed to the diodes of the L16 difference detector. They are detected and subtracted from the total load of the diodes (hence, the effect of interference does not result in a sharp change in receiver gain for the target).

To improve interference shielding of the antenna control system during automatic tracking of the target, the receiver output on the TsD-40TK unit is selected by the range gate.

S-E-C-R-E-T

50X1-HUM

The circuit functions in the following way:

Noise and the signal arrive at the L20 coincidence stage from the receiver output. The range gate from the TsD-37 range unit is also supplied to the stage from the limiter (the right half of L19). Because the range gate coincides with the range position of the target, only signals located in the gate will pass from the coincidence stage to the amplifier input (left half of L21). From the load of the cathode follower (right half of L21), the target signal is fed to the TsD-40TK antenna control unit.

3. Operation of the Receiver in the Scan Mode With Smooth Noise Interference

With the set operating in the target scan mode, the appearance of smooth (flat) noise interference is perceived in the form of gain in the noise level at the receiver output in the wide and the ShARU (AGS, automatic gain stabilization) gates.

As the noise level increases, the ShARU circuit does not function all the way because of the operation of the peaked-noise limiter. The amplitude of peaked noise increases by about a half when the presence of smooth noise interference is indicated (the "Pomekha" (interference) pilot lamp on the TsD-34TPM unit lights). Smooth noise interference is indicated in the TsD 26TK unit, to which noise and signals from the receiver output are fed.

In the presence of smooth noise interference, the pilot flips the "Pomekha-Soprov.-Zakr. luch" (interference--track--locked-on beam) toggle on the TsD-41UTPM unit to the "Pomekha" (interference) position, and the set starts functioning in the scan mode with smooth noise interference.

In this mode, the wide-gate triggering pulses are taken off the L10 multivibrator selector; and, instead of the ShARU gate, a wide-ShARU gate is fed through the buffer stage of the left half of the L11 tube.

Thus, when the station is in the smooth-noise-interference operating mode, the receiver is unlocked only during the wide ShARU gate. At the same time, the R2 relay disconnects the peaked-noise limiter. Noise from the video amplifier of the left half of the L13 tube is fed directly to the ShARU detector of the right half of the L13 tube; the R3 relay also switches in the supplementary capacitor in the UPT filter, but only in the scan mode with smooth noise interference.

Switching-out of the peaked-noise limiter induces the ShARU circuit to operate with maximum noise gain, i.e., noise will appear at the receiver output without limiting. The negative voltage of the ShARU control is now governed by the noise interference level.

S-E-C-R-E-T

Increasing the time constant of the UPT ShARU filter causes the ShARU negative control voltage at the control grids of tubes L1, L2, L3, and L4 of the IF preamplifier to decrease very gradually. The lesser signal noise received by the set from the scan zone lines, where there is no [intensive] source of noise interference, will not pass to the receiver output because of the large bias. As a result, the receiver will begin to pass noise in the time interval coinciding with the time of arrival of the maximum noise level, i.e., the interference at the receiver output will terminate at the antenna scan sweep line on which the noise source is located.

With the set in the smooth-noise-interference scanning mode, the ShARU circuit functions in the same manner as when operating with internal noise; only instead of the ShARU gate, the circuit is supplied with a wide ShARU gate from the TsD-26TK unit and the time constant of the ShARU filter is increased.

4. Operation of the Receiver in the Aiming Mode With Smooth Noise Interference

With the "Zakhvat" button depressed, the set is switched to the aiming mode with smooth noise interference; and with the help of the RI relay, the operating point of the ShARU coincidence stage (L12) is determined. This sets the noise level at the receiver output at about 15 volts; this is essential for the proper operation of the error signal detector in the TsD-40TK unit.

Simultaneously, instead of the range gate, a wide-ShARU gate is fed to the L20 coincidence stage through the limiter (right half of L19).

The R3 relay disconnects the auxiliary capacitor of the UPT filter of the ShARU circuit. This is essential for retention of the transfer characteristic of the elevation tracking system in the automatic interference tracking mode, i.e., the mode similar to the automatic target tracking mode.

Section 4. Construction of the Unit

The unit consists of the following constructionally independent parts:

a) subpanel 1 (main amplifier);

b) subpanel 2 (pulse subpanel);

c) front panel; and

d) chassis.

The main UPCh and detector, located on subpanel 1, consist of typical stages. The UPCh assembly and the detector circuit is protected by a common screen.

Located on subpanel 2 are the reception manipulator, the automatic signal control circuit (ARU circuit), the automatic noise level control (ShARU circuit), the output circuit to the range unit, the output circuits to the antenna control unit, and the Tpl filament transformer.

The following test jacks are inside the unit:

K1 - the multivibrator selector gate,
K2 - the ShARU detector input voltage, and
K3 - the UPT ARU-ShARU voltage.

The following are located on the front panel:

a) Sh_3 plug socket, and

b) R120 potentiometer-"Urov. sign." - signal level; R121 - "Urov. shum." - range channel noise level,

c) the following pulse sockets:

F1 - the I-F target signal from the TsD-32TK unit,

F2 - the narrow gate from the TsD-37 unit,

F3 - the target video signal to the TsD-37 unit,

F4 - the target video signal to the TsD-40TK unit,

F5 - the target video signal to the TsD-25TK unit,

F6 - half-gate I from the TsD-37 unit,

F15 - the target video signal to the TsD-26TK unit, and

F18 - half gate II from the TsD-37 unit;

d) the following test jacks:

G1 - the target video signal on the TsD-25TK unit,
G2 - the target video signal on the TsD-37 unit,
G3 - the target video signal on the TsD-40TK unit,
G4 - the ShARU gate,

50X1-HUM

G5 - the multivibrator selector trigger pulse,
G6 - 150 volts, regulated,
G7 - ARU voltage for recording,
G8 - 250 volts regulated,
G9 - 250 volts, regulated,
G10 - the narrow gate,
G11 - the range gate
G12 - half gate I, and
G15 - half gate II.

S-E-C-R-E-T

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

Chapter Nine

THE SYNC PULSE AND "VERKh-NIZ" MARKERS SHAPING UNIT TsD-36

Section 1. General Characteristics of the Unit

The function of the sync pulse and "Verkh-Niz" (top-bottom) markers shaping unit is as follows:

1. For synchronizing the operation of the set (keying the TsD-32TK transmitter and the RsD-33 receiver); and

2. For shaping the "Verkh-Niz" markers and for mixing the target signals with the "Verkh-Niz" markers.

On the basis of functions, the unit may be divided into the following circuits:

a) The sync circuit consisting of blocking oscillator I, blocking oscillator II, cathode follower I, delay line Lz-1, cathode follower II, and blocking oscillator III; and

b) The "Verkh-Niz" markers shaping circuit consisting of cathode follower IV: delay lines Lz-2, Lz-3, and Lz-4; the selector-mixer; the stretcher; the video amplifier; cathode follower V; modulating pulses shaping circuit; the line (middle) marker II commutator; and the commutator for the line markers I and III (upper and lower).

Section 2. The Basic Technical Characteristics of the Unit

1. Receiver triggering pulse: amplitude, 30-45 volts;

2. Transmitter triggering pulse: amplitude, 40-60 volts;

3. Target pulse at the output of the unit (F7): amplitude, 20 ± 5 volts; delay relative to the "Niz" marker, 8 ± 0.5 microsec;

4. "Niz" marker: amplitude, 20 ± 5 volts; duration 3-6 microsec;

5. "Verkh" marker: amplitude, 20 ± 5 volts; duration, 3-6.5 microsec; delay relative to the "Niz" marker, 11.5 ± 0.5 microsec.

6. Currents used in the circuits:

115-volt, 600-900 cycle: 1.2 amperes, maximum;
115-volt, 40-cycle: 100 ma, maximum;
+250- volt, stabilized: 80 ma, maximum: and
-250-volt, stabilized: 20 ma, maximum.

7. The gross weight of the unit is 5.2 [?] kg.

The circuit diagram of the unit is given in Fig 20 (see the book of diagrams).

Section 3. Description of the Circuit of the Unit

The selection circuit of the TsD-37 unit may be divided into the two following independent circuit units:

1. The sync circuit generating the transmitter and receiver trigger pulses; this circuit is intended for synchronizing the TsD-33 and TsD-32TK units.

2. The "Verkh-Niz" markers shaping circuit generating the following pulses:

a) The undelayed target pulse, which determines the "Niz" marker on the indicator screen;

b) The "Tsel'" (target) marker with an 8-usec delay; and

c) The "Verkh" marker with a 12-usec delay.

The "Verkh-Niz" markers shaping circuit permits determination of the position of the target for elevation.

1. The Sync Circuit

Wobbulated sync pulses, generated by blocking oscillator I (right half of L1), are fed to the sync circuit input from the TsD-25TK unit. Blocking oscillator I generates positive pulses which, through the buffer stage (left half of L2), are supplied to the trigger of blocking oscillator II (right half of L2). The positive pulses of blocking oscillator II are then fed to the trigger of blocking oscillator III (right half of L4) and to the cathode follower I (left half of L3). The load of cathode follower I (left half of L3) consists of delay lines Lz-1, 5, and 6 intended for generating the receiver trigger pulse delay relative to the transmitter trigger pulse. Pulses from the tap of the Lz-6 are supplied to the input of cathode follower II (right half of L3), from the output of which the receiver trigger pulses go to the TsD-33 unit for triggering the wide-gate shaping circuit. While switching the set from the set from the scan to the aiming and test modes and while operating with noise interference, the receiver trigger pulse is interrupted for transferring the operation of the receiver to the narrow gate of the TsD-37 unit.

Blocking oscillator III (right half of L4) forms the transmitter trigger pulses, which, through the L5 cathode follower, are supplied for triggering the TsD-32TK transmitter.

2. The "Verkh-Niz" Marker Shaping Circuit

On the indicator screen (TsD-34TPM unit), the "Verkh-Niz" markers appear as vertical lines located over the target marker (the upper line marker) or under the target marker (the lower line marker). The "Srednyaya stroka" (middle line) marker appears as vertical lines located, simultaneously, above and under the target marker. The "Verkh-Niz" markers are formed from the target pulse. From the output of the TsD-25TK unit, the integrated target pulse goes through F8 to the input of cathode follower IV (left half of L6): the three delay lines Lz-2, Lz-3, and Lz-4, whose total delay is 12 usec, serve as the load of the cathode follower.

The following three pulses are taken from the cathode follower:

1) The undelayed target pulse used to form the "Niz" marker;

2) The target pulse, delayed 8 usec, fixing the "Tsel'" (target) marker on the indicator screen; and

3) The target pulse, delayed 12 usec, used to form the "Verkh" marker.

The target pulse, delayed 8 usec, is taken from the Lz-3 delay line to the input of the L11 video amplifier, then to cathode follower V (left half of L12), from the output of which it is fed through the F7 R-F connector to the output of the TsD-36 unit.

The undelayed target pulse and the target pulse with 12 usec delay go to the L7 and L8 mixer selector, from the load of which they are taken to the L9 [?] pulse stretcher circuit. The stretcher circuit increases the length of the pulses from 0.5-1.6 to 3.6.5 usec, as the result of which, the "Verkh-Niz" markers appear stretched vertically on the indicator screen.

The "Verkh-Niz" markers taken from the stretcher circuit are amplified by the video amplifier (left half of L10), are mixed with the target marker (left half of L11), are amplified by the video amplifier (right half of L11), and then from the load of cathode follower V (left half of L12) are fed through F7 to the output of the unit.

Unlike the target marker, the "Verkh-Niz" markers do not have to be continuous for azimuth. The discontinuity of the "Verkh-Niz" markers is caused by the modulating pulse forming circuit, consisting of the phase inverter (left half of L13) and the frequency doubling stage (L14). The radiator scan rate voltage from the GON (reference voltage generator) is supplied to the input of the phase inverter. Two voltages, of the same frequency but opposite in phase, are taken from the output of the phase inverter. They are used by the frequency doubling stage (L14) to shape the positive and negative, square, doubled-frequency pulses. The modulating pulses from the L14 frequency doubling stage control of the operation of the L7 and L8 mixer-selector through the middle (II), upper (I), and lower (III) marker commutators. The following two circuits are used to control the passage of the pulses through the mixer-selector L7 and L8 relative to the elevation position of the target in space:

1) the middle (II) line marker commutator, and

2) the upper (I) and lower (III) line marker commutator.

The middle (II) line marker commutator consists of a plate detector (right half of L13) and an amplifier (left half of L15). A stepped voltage is supplied from the TsD-40TK unit to the input of the right half of L13. The stepped voltage consists of a 400-cycle, ac potential presented on the upper and lower lines. The detector (right half of L13) changes the mode

of operation of the amplifier (left half of L15). Positive and negative modulating square pulses of doubled frequency are fed to the input of the amplifier from the L14 frequency doubling circuit. The amplifier (Left half of L15) operates in such a way that both the undelayed and the delayed target pulses pass simultaneously through the L7 mixer-selector with the doubled frequency only when the antenna position is in the middle (II) line; the negative voltage locks the mixer-selector (L7) in the upper (I) and lower (III) lines.

The upper and lower line mark commutator consists of the L16 phase detector and the L17 amplifier. The stepped voltage from the TsD-40TK unit and the 400-cycle reference voltage are fed to the phase detector input. The phase detector produces the voltage under the action of which the L8 mixer-selector passes the target pulses with 12 usec delay in the upper line and the undelayed pulses in the lower line; in the middle line, the L8 tube is locked.

The L17 amplifier with a frequency of 2 x T30 also controls the passage of markers through the L8 mixer-selector in the upper and lower lines.

Thus, video pulses with a frequency of 2 x T30 pass to the output of the L7 and L8 mixer-selector of any of the lines; as a result, the presentation of the "Verkh-Niz" markers on all lines will be in the form of an "enclosure."

Section 4. Construction of the Unit

From the construction standpoint, the TsD-36 unit consists of the following components:

a) Chassis;

b) Horizontal panel; and

c) Front panel.

The chassis links all components of the unit. It has guide pins on the back wall for placing the unit in the cradle.

The following are located on the horizontal panel:

a) Tubes L1 through L17;

b) Transformers Tr1 through Tr5,

c) Delay lines Lz-1, 2, 3, 4, 5, and 6.

50X1-HUM

d) Installed capacitors.

Circuit elements are located under the horizontal panel.

The following are located on the front panel:

a) The Sh6 plug type connector,

b) The F7 and F8 R-F connectors,

c) Tests jacks G1 through G10.

The unit is secured in the cradle with four screws.

The dimensions of the unit are 290 x 413 x 124 mm.

The weight of the unit is 6 kg, maximum.

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

Chapter Ten

THE RANGE UNIT TsD-37

Section 1. General Features of the Unit

The TsD-37 unit is a range unit and is intended for:

a) Searching automatically for the target as to range with subsequent automatic tracking of a single locked-on target.

b) Indicating the moment of the lock-on and automatic range tracking.

c) Selecting the tracked target as to closing speed.

d) Gating the radar receiver with narrow gate.

e) Shaping the "ARU-1" and "ARU-2" gates utilized by the suppressor device of the ARU circuit of the radar's receiver.

f) Forming the range pulse and gating the target pulse at the input of the angle tracking channel.

g) Forming a signal indicating dangerous closing range (for the lamp labelled "Otvorot" (break-off) when approaching the target within a prescribed distance.

h) Forming a maximum range voltage U max., depending on the speed of closing with the target and the flight attitude.

i) Forming a minimum range voltage U min., which supplies the command "Otvorot."

Section 2. Basic Technical Features of the Unit

The TsD-37 unit can operate in two modes: in a mode for automatic range searching of the target (in the DU mode) and the mode of automatic lock-on and range tracking of the target (in the aiming mode).

The following voltages are fed into the unit's input:

1. Sync-pulses with an amplitude of 50 ± 10 volts.

2. A target pulse with an amplitude of 25 ± 5 volts.

3. Alternating voltages of a frequency of 400 cycles per second from an altitude data unit arm of from zero to 70 volts.

S-E-C-R-E-T

50X1-HUM

4. A positive voltage from a speed data unit arm with an amplitude of 0 to 70 volts.

The TsD-37 unit makes possible:

1) An automatic range search of signals reflected from the target in a delay range relative to the trigger pulse from Tn.p. to Tk.p.

2) An automatic lock-on of the signal reflected from the moving target in the search range of Tn.p-Tk.p

3) Absence of lock-on and tracking of the signal reflected from target during very rapid closing.

4) Rapid recall of tracking of a locked-on and tracked target signal in case of its loss.

5) Indicating the moment of the lock-on of the selected target signal and feeding the signal of +27 volts to the 42R6 and 42R6-1 duplicate relays of the automatic lock-on and to the "avt.z.d." light of the TsD-48 panel (during ground test).

6) The output of a narrow gate of 50-85-volt amplitude for gating the channel of the receiving unit UPCh.

7) The output of ARU-1 and Z gates with an amplitude of 60-100 volts for suppression in the ARU of the receiver.

8) The output of present range pulse with an amplitude of 30±50 volts.

9) Feeding dangerous closing signal to the "Otvorot" lamp in the form of a + 27 volts from the aircraft's electrical network during reduction of present range to target.

10) Feeding maximum range voltage U max., which is a function of the speed of approach to the target and altitude of flight.

11) Feeding minimum range voltage U min.

12) The unit normally operates with power from the following sources, requiring from these sources the following amounts of voltage:

115 volts ± 3%, 600-900 cycles per second, no more than 1.0 amperes.
36±4 volts, 400 cycles per second + 2%
+ 250 volts st.--no more than 130 ma.
-250 volts st.-- no more than 40 ma.
+ 27 volts b/s -- no more than 170 ma.

S-E-C-R-E-T

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

The unit weighs 6.5 kilograms and has dimensions of 376 x 245 x 135 mm.

The unit's circuit is illustrated in Figure 21 (see diagram book).

Section 3. Circuit Description

The range unit consists of the following:

a) An automatic followup system.

b) An automatic lock-on unit.

c) A suppressor circuit for passive noises.

d) A circuit for indicating dangerous closing range.

e) A circuit for shaping U min. and U max. voltages.

1. Operation of the Automatic Followup System

The automatic followup system consists of the following:

a) Phantastron L1, left half L12.

b) Comparator left half L3, amplifier right half L2 and search limiter, right half L3.

c) Separating diode, half L20.

d) Gate blocking oscillator, left half L4, left half L5 with delay lines, Lz-1, Lz-2.

e) Gate cathode follower, right half L5.

f) Half-gate blocking oscillator, right half L4, left half L6.

g) Half-gate cathode follower right half L6 with delay lines Lz-3, Lz-4.

h) A followup system discriminator, which consists of the coincidence stage I L7, the coincidence stage II L8, the pusle amplifier, left half L11, difference detector L9 and the cathode follower, half L17.

i) The control stage L13, right half L12.

j) A direction search switch, half L26.

k) A stage for switching the time constant of the integrator, right half L11 and relay R6.

Positive pulses of synchronization from the TsD-25TK unit are supplied to trigger the range phantastron.

The phantastron L1 and left half of L2 generate a sawtooth linear dropping voltage (so-called "fast sawtooth") with a duration of Tk.p. The "fast sawtooth" from the phantastron is fed to the comparator.

The comparator, left half L3, serves for comparing the linear dropping voltage of the phantastron with the voltage of the control stage, right half of L12, L13, fed across the separating diode half L20.

From the control stage to the comparator is fed:

a) In the DU mode -- the sawtooth linear dropping voltage (so-called "slow sawtooth").

b) In the aiming mode -- the range voltage.

The comparator fixes the moment of equality of absolute magnitudes of the phantastron and of the control stage and feeds a negative pulse at that moment which is amplified by the amplifier, right half L2, and starts the blocking oscillator of the narrow gate.

The limiter, right half L3, serves to limit the amplitude of the "slow sawtooth," and, subsequently, the beginning of the search band.

The blocking oscillator of the narrow gate, left half L4, left half L5, is designed to shape the gate-pulse with an amplitude of 50-85 volts, required for gating the receiver and for starting the blocking oscillator of the half-gate. The circuit of the blocking-oscillator serves to feed the narrow gate to the receiver on signal from relay 42R5 (in the DU mode).

The blocking-oscillator of half gates, right half L4, left half L6, is designed to shape pulses with an amplitude of 60-100 volts, of the so-called half-gates.

One pair of half-gates (the "range gates") leads to the coincidence stages of the discriminator of the followup system (L7, L8); another pair leads to the coincidence stages of the discriminator of the automatic lock-on (L14, L15); still a third pair leads to the coincidence stages of the discriminator of the ARU suppressor device in the TsD-33 receiver. The half-gate with a 0.1-microsecond delay is utilized in the circuit for shaping the dangerous closing signal, L27, and in the stage for shaping the range pulse (cathode repeater half L26).

50X1-HUM

[redacted]

Time relationships between the half-gates are fixed by delay lines Lz-3 and Lz-4, which make up a load of the cathode follower of the half-gate blocking oscillator, right half L6.

The half-gate blocking oscillator is started by pulses of the narrow gate blocking oscillator, which are delayed by delay lines Lz-1 and Lz-2. This delay makes possible the shift of the "range gates" approximately in the middle of the narrow gate.

The followup system of the range unit uses an unbalanced discriminator, which connects two coincidence stages L7 and L8, pulse amplifier, left half L11, and the difference detector L9 with cathode repeater, half L17.

The coincidence in time of the gating with the target pulse in each coincidence stage leads to appearance in each output of a negative coincidence pulse, whose amplitude and duration depend on the degree of coincidence of the pulses fed to the input. The pulses from the output of the first coincidence stage are fed to the detector of the discriminator; the pulses from the output of the second coincidence stage are amplified by the pulse amplifier, left half L11, and also flow to the detector.

The difference detector of the L9 discriminator consists of two arms. One arm separates the negative voltage, detecting the coincidence pulses of the first coincidence stage, the other arm separates the positive voltage, detecting the amplified coincidence pulses of the second coincidence stage.

The difference of these voltages (the control voltage) is fed across the cathode repeater, half L17, to the control stage. When the target signal disappears, the coincidence pulses disappear and the control voltage will be determined by the voltage of the search direction commutator, half of L26.

Control stage L13, left half L12, is represented as a stage with a capacitive feedback, capable of operating in two independent modes, depending on the voltage on the control grid: the mode for generating the so-called "slow sawtooth", and integration mode.

On the disappearance of the target signal, the discriminator does not generate any signal and into the control stage across the cathode repeater of the discriminator, half L17, is fed a constant positive voltage from the commutator search direction, half L26.

In this instance, the control stage operates as a transiton oscillator of "the slow sawtooth".

S-E-C-R-E-T

[redacted]

50X1-HUM

50X1-HUM

As pointed out above, the voltage from the control stage is fed to a comparator, inducing a smooth change of the delay of the negative pulses of the comparator and, subsequently, of the pulses of the gate and half-gates relative to the trigger pulses. In this case, the half-gates of the followup system, while smoothly moving from Tn.p to Tk.p., carry out search for target as to range at a rate fixed by the period of the "slow sawtooth."

With the admission to the unit of the target pulse and its synchronization in time with the half-gates of the discriminator of the followup system, the discriminator separates the control voltage. Due to the effect of this voltage, the control stage is converted from generation mode to integration mode. The followup system discontinuses target search as to range and switches over to automatic tracking of the target.

The control voltage, which is separated by the discriminator of the followup system, moves continuously across the integrator to the comparator, holding the target pulse between the half-gates of followup system's discriminator.

The time constant commutation stage of the integrator, right half of L11, relay R6, is designed to prevent disruption of oscillation of the transitron oscillator and integrator time constant commutation. During the target range search DU mode, the stage is open and the relay is energized.

During lock-on of the target pulse by the follow up system half of the L11 tube is cut off by the discriminator control voltage, relay R6 is de-energized and by its contacts the transitron oscillator circuit is blocked off and the integrator time constant is increased. Increasing the integrator time constant leads to an increase in the scale of the speed voltage which is necessary for operation of the speed selector.

2. Operation of the Automatic Lock-On

The automatic lock-on consists of the following stages:

a) The coincidence stages L14, L15 and the difference detector of the discriminator of the automatic lock-on L16;

b) The amplifier half L17.

c) The electro-mechanical relay L10, and relays R1, R2.

The automatic lock-on switches the radar from the scanning to the aiming mode.

S-E-C-R-E-T

50X1-HUM

50X1-HUM

In order to improve noise immunity of the automatic lock-on, a balanced discriminator is utilized at the unit's input. This discriminator consists of two identical coincidence stages and a difference detector, L14, L15, L16.

From the first coincidence stage output will be taken negative pulses, resulting from coincidence during half gate, with noise pulses. From the output of the second coincidence stage will similarly be taken negative pulses resulting from half gate coincidence, with noise pulses. The negative pulses from the coincidence stages pass to the difference detector.

The L16 difference detector is operated thusly: during detection of the negative pulse from the first coincidence stage the detector separates a positive dc voltage and, during the detection of the negative pulse from the second coincidence a negative dc voltage. Both voltages are partially or fully mutually compensated and, hence the voltage at the detector's output is approximately equal to zero. The automatic lock-on unit does not operate. Thus, noise immunity of the automatic lock-on is insured.

In the automatic target range tracking mode, (aiming), the target pulse is fed to both coincidence stages. A negative pulse will not be taken from the output of the first coincidence stage, since its half-gate always appears to be delayed in relation to the target pulse (located behind the "range gates").

The time position of the half-gate in the second stage of coincidence corresponds to the position of the target and at the output of the second stage a negative coincidence pulse is separated.

As a result of this, a negative voltage appears at the output of the difference detector. The negative voltage from the detector is amplified by a dc amplifier, half L17, and is further fed to electro-mechanical relay L10, causing it to operate.

In the event that the target signal disappears, the detector of the discriminator of the automatic lock-on terminates the voltage to amplifier half L17; however, the automatic lock-on is not turned off suddenly, but with a delay, brought about by the "memory" of the electro-mechanical relay. Thanks to the presence of the "memory" in the followup system, the "range gates" continue to move according to the range in the direction of the moving target. During this time, the followup system, due to the memory system, tracks the target's range.

After the automatic lock-on is shut off, the relay contacts switch the radar over to scanning mode.

3. Operation of the Passive Noise Suppression Circuit

The circuit consists of the following:

a) Speed selector, left half L18.

b) Stage for blocking the automatic lock-on unit, right half L19.

c) Search shifting stage, left half L19.

d) Search multi-vibrator, L2, L30.

e) Stage for switching off the search shift, right half L18.

The speed voltage developed by the followup system's range finder is fed into the speed selector, left half L18. Moreover, a positive voltage is also fed into the speed selector from the DVS speed data unit.

A stage for blocking the automatic lock-on unit, right half L19, bridges the amplifier of the automatic lock-on unit, half L17. Tube of the electro-mechanical relay system is locked and relays R1 and R2 are de-energized. After the automatic lock-on unit is switched off, the stage of the search shift (left half L19, relay R3) facilitates bounces of the gate-pulse from the target pulse in the direction of the greatest range and the starting of the multi-vibrator of the return search.

The search multivibrator, L2, L30, is started by a voltage fed from the search shift stage at the moment of the operation of relay R3.

The positive pulse of the multi-vibrator opens the switch search tube, half L26. The voltage at the output of the stage becomes negative, which leads to a steady increase in the voltage at the control stage output and, subsequently, to a change in the search direction from the end of the distance of the bounce of the gate pulse, to the beginning of the search range.

4. Operation of the Dangerous Closing Range Signal Circuit

This circuit is composed of the following:

a) Fixed duration phantastron L28.

b) Coincidence stage and amplifier L27.

c) Electro-mechanical relay and range pulse cathode follower, half L26, R4.

The circuit transfers a signal of +27 volts to the "O" light of unit TsD-34TPM, on closing of the aircraft-interceptor with the target at dangerous closing range.

The unit operates in the following manner.

The square pulse of phantastron L28, whose duration depends on the altitude of the flight, can assume two fixed magnitudes, changes smoothly depending on the speed of closing with the target and is fed into the coincidence stage.

The coincidence stage, left half L27, fixes the moment of coincidence in time of the phantastron pulse and the half-gate with a delay of 0.1 micro-seconds (the half-gate, which coincides with the pulse of the tracked target).

In this case, if the delay of the half-gate, and subsequently, of the target pulse, does not coincide with the pulse of the phantastron, the coincidence stage does not supply any voltage.

With a reduction of the delay of the half-gate (in the automatic tracking of the target pulse) up to the moment of its coincidence with the pulse of the phantastron, the coincidence stage distributes a negative voltage, which subsequently flows to the amplifier.

The amplifier, right half L27, is designed to amplify the voltage developed by the coincidence stage and to change its polarity. The voltage received in the outlet of the amplifier, is fed into electromechanical relay, half L26, relay R4.

The electro-mechanical relay is designed to distribute the dangerous closing signal as a +27 volts (aircraft circuit). By blocking the tube of the amplifier with the voltage of the coincidence stage, the electro-mechanical relay tube is opened and relay R4 operates. The relay contacts close the circuit of +27 volts (aircraft's circuit) for feeding the "O" ("Otvorot") signal.

5. Operation of the Circuit for Forming Voltages U min and U max.

The circuit consists of the following:

a) Differentiating circuit C59 and R142.

b) Vibrating rectifier VP-1.

c) A two-stage alternating voltage rectifier, L24, and cathode follower, left half L12.

S-E-C-R-E-T

[redacted]

d) Rectifier I25 and cathode follower, left half I22, of the speed voltage.

e) Rectifier for altitude voltage, half I20.

f) The cathode follower for the height voltage, half I22.

g) Circuits for forming the voltage U_{V_0} max.

h) Circuits for forming the voltage U_{V_0} min.

i) The summing circuits I, II, III.

j) The cathode follower U max., left half I21.

k) The cathode follower U min., right half I21.

1. The circuit for shaping the U min. and U max. voltages is the basic link of the analogue computer, which, during the mode of automatic tracking of the target's range, processes information fed as a voltage of present range to the target and as a voltage of the flight altitude of the interceptor.

Information from the computer's output is fed into the TsD-46 unit as a U max. voltage, necessary for developing the permissible firing zone visually observed on the screen of the radar indicator. The U min. voltage is fed to phantastron (I28) of the dangerous closing range circuit. The magnitude of the U max. voltage at each current moment of time takes account of the flight altitude of the interceptor, as well as its closing speed with the target.

2. The circuit operates in the following manner. The range voltage generated by the followup system of the range finder is fed to the differentiating circuit across contacts of the automatic lock-on unit and across a filter of low frequencies.

In the event that the target closing speed is zero, a non-variable range voltage is fed to the differentiating circuit. The voltage at the output of the differentiating circuit is equal to zero.

In the event that the target range does change, the range voltage at the input of the differentiating circuit is changed so as to correspond proportionately either to the closing speed or to the receding speed from the target.

A dc speed voltage will appear on the differentiating circuit, the magnitude of which voltage will be proportionate to the rate of change of range to the target and the sign will indicate approach

[redacted]

toward or receding from [the target]. Since the voltage which is formed in the differentiating circuit is inadequate for shaping the voltages U max. and U min., it must be preamplified.

Because the circuits of the dc amplifiers possess a drift of zero whenever there is a change in the filament voltage and in the supply voltage, there is utilized at the unit's input the ac voltage amplifier I24 with vibro-converter, which converts the dc speed voltage after the differentiating circuit into an alternating voltage with a frequency of 400 cycles per second.

From the output of the amplifier the alternating speed voltage is fed to the speed voltage cathode follower, left half L12, and then to the rectifier, I25.

The rectifier converts the ac speed voltage to a dc voltage, which is subsequently fed to the speed voltage cathode follower, left half I22, which serves as a buffer stage between the speed voltage rectifier and the stages for shaping the U max. and U. min. voltages.

The two voltages are taken from the cathode follower's output and differ by the scaling factor T_2, that is, U_v and T_2U_v.

The voltage T_2U_v is added by the summing circuit II to the voltage U_{v_0} min. and is fed to the cathode follower of the U min. voltage, right half I21, and from the load of the cathode follower. of the summary voltage U min. = T_2U_r +uvo. min. is fed into the phantastron of the dangerous closing range circuit.

From the output of the altitude cathode follower the voltage is fed to summing circuit I, where it is added to the speed voltage.

Section 4. The Unit's Design

The TsD-37 unit is enclosed in an aluminum rectangular chassis. The unit is secured in the central frame of the radar by means of two locking screws, which are placed in the forward panel, and two regulating pins, located in the unit's after wall.

The front panel of the unit contains the following:

A power supply socket for supplying current to the Sh7 unit.

Four pulse sockets: F2 (gate); F3 ("Signal"); F6 (ARU-1); F13 (ARU-2).

Eight monitoring jacks: G1 ("Signal"); G2 ("Gate"); G3 (Synchronization pulse); G4 ("Storage"); G5 (U max.); G6 (U min.); G7 ("Command"); G8 ("Range voltage"); 10 potentiometers: -R2 ("Nach. ur."); R ("Krutizna"); R18 ("Range min."); R110 ("Storage"); R198 ("Command"); R161 ("Speed"); R149 ("Dmax."); R145 ("Dmin."); R153 ("Altitude"); R121 ("Selection").

The unit's installation is in the lower portion of the chassis. The TsD-37 unit interacts with the DVS box in the air speed circuit. The potentiometer RI regulates the speed of the box scale of the DVS. The principal circuit is in Figure 22 (see book of diagrams).

In the housing are installed all suspended parts, wheich are attached to distributing plates and to tube socket lugs. The unit's installation is level, of the open type and convenient to operate. The larger-sized parts are placed in the unit's upper section.

The transformers, delay lines and other parts in the unit have been prepared in accordance with appropriate drawings, OST (All Union Standards), GOST (State All-Union Standards), TU (Engineering Specification) and other standards.

The unit weighs 6.5 kilograms and its dimensions are: 245x376x135 mm.

S-E-C-R-E-T

Chapter Eleven

ANTENNA CONTROL UNIT TsD-40MK

Section 1. Purpose of Unit

Antenna control unit TsD-40MK is intended for shaping and amplifying signals for controlling the antenna:

1) in the space scanning mode;

2) in the DU (range system) and locked-on beam modes;

3) in the automatic tracking mode;

4) in the mode of automatic tracking of smooth noise interference.

Unit TsD-40MK provides:

a) in the scanning mode -- searching movement of the antenna along the trajectory shown in Fig. 5;

b) in the DU and locked-on beam modes;

c) in the automatic tracking mode -- antenna movement for following a target;

d) in the mode of automatic tracking of smooth noise interference -- movement for following the source of noise interference.

The unit's circuit can be broken down, according to functions performed, into the following channels:

1) azimuth search channel;

2) channel of search and DU for elevation;

3) circuit for separating out error signals;

4) channel of DU and automatic tracking for azimuth;

5) channel of automatic tracking for elevation.

Section 2. Basic Technical Data of the Unit

1. Operation of the circuit of the search channel must take place with the turning of the rotor of selsyn 3lSn3 through 106± 4°.

2. Voltage of "jumps" entering unit TsD-36 to the commutation circuit of the "Verkh-Niz" markers:

$$U_1 = 0.5v$$

$$U_2 = 30v \begin{smallmatrix}+10v\\-4v\end{smallmatrix} \text{ of phase } 0^\circ$$

$$U_3 = 30v \begin{smallmatrix}+10v\\-4v\end{smallmatrix} \text{ of phase } 180^\circ$$

with the sequence: U_1, U_2, U_3, U_1, etc.

3. The current of the UPT (direct current amplifier) of the azimuth search channel must be 5 $\pm$ 0.3 ma.

4. The voltage of "jumps" entering the elevation search channel G12 should be:

$$U_1 = 0.3v$$

$$U_2 = 1.7v \pm 0.2v \text{ of phase } 0^\circ$$

$$U_3 = 1.7v \pm 0.2v \text{ of phase } 180^\circ$$

with the sequence U_1, U_2, U_3, U_1, etc.

5. Steepness of the amplitude characteristic

In the DU mode:

of the azimuth channel -- 10 ma/v $\pm$ 1.5 ma/v,

of the elevation channel -- 1.0 ma/v $\pm$ 0.1 ma/v.

In the automatic tracking mode:

of the azimuth channel and elevation channel -- 0.35 ma/% $\pm$ 0.03 ma/%

In the mode of automatic tracking of noise interference:

of the azimuth channel and elevation channel -- 0.45 ma/% $\pm$ 0.05 ma/%

6. Current requirements of the circuits:

115 v of 400 cycles -- no more than 700 ma

+27v -- no more than 300 ma

+250v st. -- no more than 90 ma

-250v st. -- no more than 5 ma

7. Unit dimensions -- 378 x 160 x 124 mm.

8. Weight of unit -- no greater than 3.6 kg.

Diagram of unit in Fig. 23 (see book of diagrams).

Section 3. Description of the Unit System

1. Space Scanning Mode

The antenna control unit in the scanning mode provides for the movement of the antenna along the trajectory shown in Fig. 5.

The movement is accomplished by the continuous reversing operation of azimuth motor 3112, which provides for movement of the antenna along an azimuthal line, and by the switching-on of elevation motor 3111 at the terminal points of each azimuthal line for transferring the antenna from one azimuthal line to another.

Control of the azimuthal movement of the antenna is provided by a circuit with the following tubes: L1 -- amplifier; L2 -- phase detector; L3 -- azimuth search trigger; L4 -- direct current amplifier (UPT).

Two voltages of the first and second phases of the stator of the azimuth selsyn 31Sn3 are fed into amplifier L1. At the moment the antenna reaches the terminal point of an azimuthal line, the voltage at the input of one half of amplifier L1 and, consequently, at the input of the corresponding half of phase detector L2 is equal to zero, and this is the signal for reversing trigger L3.

The reversing of trigger L3 changes the imbalance sign of the currents of UPT L4, which determines the phase of the control voltage of the azimuth motor and, consequently, the direction of the antenna mirror along the line.

Upon the arrival of the antenna at the opposite terminal point of the azimuthal line, the voltage at the other half of L1 and at the corresponding input of the tube of phase detector L2 is equal to zero. Trigger L3 is returned to its original position and the antenna returns along the line in the opposite direction.

The changing of the elevation of the antenna must occur at the end of each azimuthal line.

seconds relative to every third pulse of the triggering of trigger 1, activate trigger 1.

The total voltages from the grids of the left half of L6 and the left half of L7 and the left half of L6 and the right hlaf of L7 pass through summing circuits R54; R143 and R55; and R142 to the corresponding halves of the modulator (L8 -- twin triode) and are the voltages which control the triggering and blanking of the halves of the modulator tube in the following sequence:

bottom line -- left half of L8 open
(right half of L8 closed)

top line -- right half of L8 open
(left half of L8 closed)

middle line -- both halves of L8 closed

bottom line -- left half of L8 open
(right half of L8 closed), etc.

Two antiphase reference voltages with a frequency of 400 cycles are fed into the modulator -- one directly from transformer Tr1, the other through contacts 3 and 4 or relay R5.

When one of the halves of the modulator tube is triggered, a voltage with a frequency of 400 cycles (the voltage of the "jumps see Fig. 9) appears in the load of the modulator, causing the antenna to jump in elevation from line to line. The phase of the voltage of the "jumps" is determined by the phase of the reference voltage in the cathode of the open half of the modulator tube.

From the modulator, the voltage of the "jumps" enters unit TsD-36 to the commutation circuit of the "Verkj-Niz" markers, and also passes through the divider to the circuit of search and DU for elevation for controlling the operation of the elevation channel in the scanning mode.

The system of search and DU for elevation incorporates the following tubes: L12 -- amplifier; L13 -- phase detector; L14 -- UPT.

In the scanning mode three voltages of 400 cycles enter L12 simultaneously: the voltage of the antenna elevation correction from unit TsD-42, the voltage of the adjustment of selsyn 31Sn1, and the voltage of the "jumps."

The algebraic sum of the voltage of the antenna elevation correction and the voltage of the adjustment of selsyn 31Sn1 causes the antenna to move from the top line to the middle line and lock on it. The voltage of the "jumps" provides for the movement of the antenna from the middle line to the bottom line and from the bottom line to the top line.

With the appearance of the voltage of the "jumps," the voltage of the selsyn adjustment at the input of amplifier L12 increases. The algebraic sum of the three voltages at the input of the amplifier is amplified and delivered to phase detector L13.

This voltage, which coincides with the reference voltage of 400 cycles, when applied to one half of tube L13, causes a decrease in the current of that half of the tube and, as a result, an increase in the voltage at the input of the UPT. The corresponding voltage from amplifier L12 in the other half of the tube of phase detector L13 is in antiphase with the reference voltage, and this causes an increase in the current of that half of the phase detector and a drop in the voltage at the input of the UPT of one half of L14.

Thus, in the windings of the magnetic amplifier of elevation in the anode circuits of UPT L14, an imbalance of currents equal to the difference between the currents of both halves of the UPT tube appears.

The control voltage of the elevation motro appears at the input of the magnetic amplifier. Its phase is determined by the phase of the current at the input of amplifier L12 and its magnitude is in proportion to its amplitude. The elevation motor 31M1 changes the position of the mirror of unit TsD-31TP with respect to elevation. The voltage of the adjustment of selsyn 31Sn1 at the input of amplifier L12 is changed so that the algebraic sum of the three voltages at the input of the amplifier drops toward zero.

The appearance of the voltage of the "jumps" of phase 0° and 180° at the input to the system of search and DU for elevation corresponds to the jumping of the antenna to the bottom or top line, respectively; and its absence corresponds to the movement of the antenna to the middle line.

With the removal of the voltage of the "jumps" under the influence of the algebraic sum of the voltage of the antenna elevation correction and the voltage of the selsyn adjustment remaining in the input of the system of search and DU for elevation, the antenna returns to the middle line. At the same time the voltage of the selsyn decreases in amplitude and becomes equal to the antiphase voltage of the antenna elevation correction at the moment the antenna is placed on the middle line.

Thus, at the moment the antenna is set on any line, the algebraic sum of the voltages at the input to the system of search and DU for elevation is equal to zero.

The absence of voltage at the input of amplifier L12 corresponds to the balance of the currents of the UPT of the channel of the system of search and DU for elevation.

The station provides for suppression of "ground" pulses during flights at low altitudes. This is accomplished by switching off the bottom line and moving yhe scanning sector up by means of the toggle switch "Zashchita ot zemli" (Protection against the ground), located in the cockpit. When this switch is placed in the "Men'she" (less) position, "+27v" are sent to the winding of relay 5 of the TsD-40TK unit. This triggers the relay, which breaks the circuit from the transformer to modulator L8 supplying the reference voltage, the phase of which causes the transfer of the antenna to the bottom line. The voltage of the "jumps" takes on the shape shown in feg. 10; the flat mirror of the antenna changes its trajectory to that shown in fig. 11.

When the switch "Zashcita ot zemli" is placed in the "Bol'she" (more) position, a voltage of +27v is sent to the winding of relay R6, which is triggered, and its closed contacts 5 and 3 connect the voltage from the filament windings (3-4) of transformer Tr1 to the divider R149, R150, R151. The voltage from the divider is added to the voltage of the elevation selsyn at the input of L12. The total voltage causes the antenna mirror to tilt upward.

2. The Range System Mode of the Antenna

When a target appears on the radarscope in the scanning mode, the pilot pilots his aircraft so that the target is in the lock-on zone with respect to azimuth and angle of elevation and at a distance facilitating a lock-on. To lock on the target the station goes over to the intermediate mode -- the "DU" mode -- in advance.

In the "DU" mode the antenna is set according to elevation and azimuth.

To switch the station over to the "DU" mode the pilot presses the "Zakhvat" (lock-on) button on the aircraft's control stick. This closes the circuit supplying a voltage of +27v from the aircraft's electrical wiring system to the DU relays of unit TsD-42 (42P5; 42P5-1; 42P5-2) and 40R3. When triggered, the DU relays of unit TsD-42 shift the phase of the stator os selsyn 31Sn3 (disconnects phase 3 from the "current ot ground" and connects phase 1 to it), and also connects a voltage of +250v st. to the anodes of the tube of the amplifier and the phase inverter of the channel of DU and AS for azimuth 40L9. Relay 40R3 closes the circuit of the current of UPT L11 of the azimuth channel and breaks the circuit supplying the voltage of "jumps" to the system of search and DU for elevation.

When the voltage of "jumps" is cut off, the antenna mirror is set on the middle line with respect to elvation by the remaining voltage of the adjustment of selsyn 31Sn1 and the correction voltage.

The adjustment of the middle line to the angle of "attack" with respect to elevation is accomplished with the tuning of the station by the regulation

S-E-C-R-E-T

of the antenna correction voltage by the potentiometer ("Nul'N") (Zero N).

The antenna is set on zero with respect to azimuth by the voltage of selsyn 31Sn3 taken in the DU mode from the second phase of the selsyn stator relative to the grounded first phase.

The voltage of the selsyn passes through the amplifier of the left half of L9 to the phase inverter of the right half of L9, and two antiphase voltages of equal amplitude are fed into the grid of phase detector L10.

The anode feed of phase detector L10 in the DU mode is a squared voltage with a frequency of 400 cycles.

In the absence of the selsyn voltage at the input of the amplifier of the left half of L9, voltages are taken from the load of the phase detector to the grids of UPT L11, providing a balance of the currents of the UPT. an imbalance of the currents of the UPT. The control voltage of the azimuth motor appears at the input of the magnetic amplifier. The motor reduces the selsyn voltage at the input of the amplifier of the left half of L9 toward zero. The moment a zero value is established for the voltage from selsyn 31Sn3 at the input of the circuit, the antenna is at "zero" elevation.

Thus, the antenna mirror is set at the angle of "attack" with respect to elevation and at "zero" with respect to azimuth.

3. Locked-On Beam Mode

When the station is switched over to the locked-on beam mode, the antenna control unit TsD-40TK is switched to the "DU" mode.

The antenna is set at the angle of "attack" with respect to elevation and at "zero" with respect to azimuth.

4. Automatic Tracking Mode

Range lock-on occurs when the "Zakhvat" button is pressed in the event of a target coming into the lock-on zone with respect to azimuth and angle of elevation and when the range is sufficient.

The automatic range lock-on system is put into operation and the "current to ground" is fed to the winding of relay 42P6 (relay of the automatic lock-on system) through contacts 7 and 12 of relay 37R1 and the "Sbros" button in the cockpit.

A current of -27v passes through closed contacts 7 and 6 42R6 to the connection of relays 40R1 and 40R2, switching the antenna control unit to the automatic tracking mode.

The contact groups of relay 40R1 switch over the circuit of the atuomatic tracking channel for azimuth; specifically, the reference voltage with a grequency of 400 cycles is cut off from the input of the squarer of the azimuth channel of the right half of L16 and the reference voltage from the GONa with a frequency of T30 is switched on. The input of the phase inverter of the right half of L9 is cut off from the amplifier of the left half of L9 and connected to the output of the circuit for separating out error signals L15.

Relay 40R2 commutates the circuit of the automatic tracking channel for elevation -- cuts off the UPT of the channel of DU and elevation search L14 from the magnetic amplifier of elevation and connects to it the UPT of the automatic tracking channel for elevation L19.

When the station is switched over to the automatic tracking mode, the video pulses of the target, amplitude-modulated according to the sinusoidal law by the scanning of the radiator, are sent to unit TsD-40TK (peg f4) from the output of receiver TsD033. The video pulses are detected by the peak-detector of the left half of L15.

As a result of the detection, the modulation envelope of the video pulses, the so-called error signal, which contain information on the angular position of the target, is separated out. The amplitude of the error signal is proportional to the angle of mismatch between the equisignal direction and the direction to the target.

The phase of the error signal characterizes the direction of the deviation of the target with respect to the equisignal direction. The error signal simutaneously enters the azimuth channel and the elevation channel, the circuits of which are completely identical. Therefore, the operating principle of only the azimuth channel will be presented. The operation of the elevation channel is the same.

In the automatic tracking mode theerror signal in the fomr of a sinusoid with a frequency of T30 passes from the output of the circuit for separating out error signals L15 to the input of the phase inverter of the right half of L9. The phase inverter divides the "error signal" into two sinsoidal voltages of equal amplitude which are 180° out of phase with each other. These voltages enter the input of phase detector L10, the anode feed of which is the squared voltage of the azimuth GON , and cause voltage drops, which have the same magnitude but are opposite in respect to the sign of the increment, in the loads of the phase detector.

The voltages from the loads of the phase detector, acting on the grids of UPT tube L11, create an imbalance of the currents of the latter. The magnitude of the imbalance of the currents and, consequently, the magnitule of the increment of voltage drops in the loads of the phase detector are proportional to the amplitude of the error signal (i.e. to the angle of mismatch), and the sign is determined by the phase of the

error signal (i.e. the direction of the deviation of the target).

The imbalance of the currents of the UPT is converted by the magnetic amplifier (in unit TsD-44) into the control voltage of the motor, under the action of which the motor moves the antenna mirror in respect to azimuth in the direction of decreasing the angle of mismatch until the equisignal direction and the direction to the target coincide.

The circuit of the automatic tracking channel for elevation incorporates the following tubes: the right half of L17 -- phase inverter; L18 -- phase detector; L19 -- UPT.

The voltage of the error signal goes directly to the input of the phase inverter of the right half L17. The anode voltage of phase detector L18 is the reference voltage of the elevation GON , squared by squarer L16 and out of phase with the voltage of the azimuth GON .

The operation of the automatic tracking channel for elevation is exactly the same as the operation of the automatic tracking channel for azimuth.

Thus, the separation of the azimuthal and elevation angle components of the error is accomplished in phase detectors L10 and L18 through the comparison, with respect to phase and amplitude, of the error signal and the GON voltages, one of which is "attached" to the position of the radiator in space in the azimuth plane, the other -- to the elevation plane.

5. Mode of Automatic Tracking of Smooth Noise Interference

In the event of smooth noise interference, the station is switched over to the "interference" mode by means of the mode switch on unit TsD-41TPM. With this, a voltage of +27 v enters the windings of relay 40R4; and 40R2. The antenna control unit TsD-40Tk is switched over to the mode of automatic tracking of smooth noise interference.

In this mode amplitude-modified noise interference enters the high-frequency input (pin f4) of unit TsD-40TK from unit TsD-33.

The separation of the error signal and its division into components of azimuth and elevation is accomplished in the same manner as in the automatic tracking mode.

In comparison with the automatic tracking mode, the amplification factor of the error signal in the right half of L15 during the operation of relay 40R4 increases approximately 1.3 times in the mode of automatic tracking of noise interference. The increase in amplification results from the fact that in the mode of automatic tracking of noise interference the antenna is only receiving; therefore the amplification of the channel of angle tracking of noise interference is decreased. Consequently, the quality of the

tracking system (i.e. the speed of tracking) during the tracking of noise interference decreases. To maintain the quality of the channel of angle tracking during operation for noise interference the amplification factor of the amplifier of the error signal (right half of L15) in unit TsD-40TK is increased.

Section 4. Operation of Terminal Switches for Limiting Antenna Movement

For reducing wear of the mechanisms of the antenna reducers there is a systme for limiting the voltage in the control windings of the azimuth and elevation motors upon arrival of the antenna at the maximum angles of operation.

The circuits of the terminal switches for the azimuth and elevation channels are the same, and only the circuit of the elevation channel is described below.

When the antenna arrives at the maximum angle of operation, the top or bottom terminal switch is triggered. Suppose that under the action of the control signal fed to the grids of UPT L19, the antenna moves downward; the current through the windings 44Wu2, 44Wu1 is greater than the current through the windings 44Wu2, 44W71, which corresponds to the higher potential at anode 1 of tube L19. When the bottom terminal switch KV2 is triggered, relay 42R9 is switched on, closing with its contacts the circuit of diode 42D1. A current flows through diode 42D1, equalizing the currents through the control windings of the magnetic amplifier. The voltage at the output of the magnetic amplifier drops to 2-4v and the motor shuts down.

Obviously, changing the polarity of the control signal in the grids of UPT L19 must cause the appearance of a voltage at the output of the magnetic amplifier which will cause the antenna to move in a direction away from the terminal switch, i.e. upward. This is possible since in this case the increase in current passes through the control windings [omission?] i.e. the potential of anode 1 is lowered with respect to anode 6. There will not be an equalizing current because of the large reverse resistance of diode 42D1. When the antenna leaves the mechanical stop the terminal switch is turned off and relay 42R9 is released.

The operation of the terminal switch for limiting the upward movement is the same as that of the bottom terminal switch.

Section 5. Construction of the Unit

The unit os mounted on a rectangular chassis. The unit is fastened to the main frame of the station by means of three screws in the front panel and two guide pins in the rear wall. On the face panel of the unit are the following: feed joint of unit Sh10, high frequency joint f4, control jacks G1 and G19, five potentiometers: R70 ("Balance A"), R127 ("Balance NDU")

50X1-HUM

[redacted]

and R148 ("Amplification of noise interference"), R110 ("Amplification of AS") with scales on the axis for convenience of reading the amplification.

On the Chassis of the unit are all large parts and four potentiomenters: R2 (Balance of Jumps"), R53 ("Magnitude of Jumps"), R24 ("Balance of Search"), and R25 ("Speed of Search").

The assembly is flat, of the open type, located in the bottom part of the unit.

S-E-C-R-E-T

[redacted]

50X1-HUM

Chapter Twelve

MAGNETIC AMPLIFIER AND ANTENNA TILT STABILIZATION

UNIT TsD-44TP

Section 1. Purpose of Unit

The purpose of the magnetic amplifier and antenna tilt stabilization unit TsD-44TP is the amplification of power in the automatic control system of the antenna electric motor 31M1 (elevation), 31M2 (azimuth), and 31M3 (tilt) and the stabilization of the scanning zone position in space in relation to the longitudinal axis of the plane when tilting.

Section 2. Basic Technical Data of the Unit

1. Minimal output voltage of the magnetic amplifiers MU1, MU2 and MU3 in the balancing of currents in the control windings should not exceed 8 volts.

2. The steepness of the velocity characteristic in the unbalancing of the control currents, ΔI equals 4ma - :

   MU1 K equals 10 ± 2 deg/sec ma

   MU2 K equals 4.5 ± 1.5 deg/sec ma

3. The coefficient of amplification of the tilt channel operating on motor EM-15M should maintain a steepness of velocity characteristic such that K equals 10 ± 2 deg/sec. v.

4. The zone of insensitivity of the magnetic amplifiers MU1 and MU2 should not exceed ± 0.2 ma, and that of MU3 - ± 0.4 ma.

5. The time relay maintains a time delay in operation of

S-E-C-R-E-T

1.5±0.5 sec.

6. The voltage put out by the unit for supply of the transmitting selsyn of the 1186A signal distributor is 36±2.5 v. at 400 cps.

7. The current consumption of the unit along the 115 v. at 400 cps circuit should not exceed 3 amps.

8. Unit dimensions - 362 x 235.5 x 135 mm.

9. Unit weight - not more than 8 kg.

Block diagram of the unit is on Fig. 24 (see book of diagrams).

Section 3. Description of Unit Circuit

The block diagram of the TsD-44TP unit can be divided into the following component parts:

antenna tilt control circuit L2 and L6;

magnetic amplifier of the MU1 azimuth channel;

magnetic amplifier of the MU2 elevation channel;

magnetic amplifier of the MU3 tilt channel.

The antenna tilt control circuit consists of:

time relay circuit L6;

amplifier L2;

phase detector L3;

UPT of tilt L4;

UPT OS (obratnaya svyaz': feedback) L5.

In the modes of scanning and DU, (up to lock-on of target for range), the point of entry of amplifier L2 is through the normally

S-E-C-R-E-T

closed contacts 3 and 4 of relay R4 connected to the rotor winding of the antenna tilt stabilizer selsyn 31Sn6.

The latter is a receiver selsyn of the tracker tilt transmission system from the AGD-1 gyroscopic remote attitude transmitter through the 1186A signal distributor at the input of the antenna tilt control circuit.

During lateral tilts of the airplane relative to the longitudinal axis a mismatch occurs between the AGD-1 selsyn transmitter and the selsyn receiver of the 1186A signal distributor. The mismatch signal from the rotor of the selsyn receiver of the distributor is fed, in the form of a voltage frequency of 400 cps, to the tilt output circuit of the distributor, consisting of a signal amplifier and a motor. The amplified voltage controls a motor which turns the rotor of the distributor selsyn transmitter connected directly with the 31Sn6 selsyn receiver of the TsD-31TP unit.

The selsyn receiver rotor and the selsyn transmitter rotor of the distributor are directly connected to one another through a reducer with a gear ratio of 1:2. In such manner the selsyn transmitter rotor of the distributor turns at an angle equal to twice the tilt angle of the airplane.

The change in the position of the distributor selsyn transmitter rotor causes a redistribution of current in its stator windings which is transmitted to the windings of the stator of the 31Sn6 selsyn receiver.

[redacted]

A voltage originates at the 31Sn6 selsyn rotor which proceeds to the input of the amplifier L2 of the antenna tilt control through contacts 3 and 4 of relay R4 of unit TsD-44TP.

Amplified voltage proceeds to the input of the phase detector L3, into which are fed, in anti-phase, two reference voltages with a frequency of 400 cps from the reference transformer Tr1.

There originates at the output of the phase detector an unbalance of voltages which, affecting the input of the d-c amplifier L4, causes an unbalance of currents flowing through the control windings of the tilt magnetic amplifier MU3.

At the MU output there appears a 400-cps voltage for control of the tilt electric motor 31M3. The motor turns the tilt platform of the antenna in the direction opposite to that of the tilt of the airplane, in this manner selecting the tilt of the airplane. Simultaneously the rotor of the 31Sn6 selsyn rotates through the reducer with a gear ratio of 1:2 approaching the condition of the rotor of the selsyn transmitter of the 1186A signal distributor. During this time the mismatch signal at the output of amplifier L2 of the antenna tilt control circuit decreases, and when the rotor of selsyn 31Sn6 reaches the condition of the rotor of the distributor selsyn transmitter it is equal to zero.

The tilt motor stops operating. The tilt platform turns out to be skewed on the angle of the airplane in the direction opposed to the tilt of the airplane. Thus, during lateral tilts of the airplane in the scanning and DU mode the position of the scanning zone in space is

[redacted]

stabilized.

After lock-on of the target for range a +27-v. voltage proceeds from the automatic lock-on relay 42R6 of unit TsD-42 to the winding of relay R3 of unit TsD-44TP. Relay R3 operates and switches in a stabilized +250 v. voltage to the time relay circuit and connects the frame at its output; during this time the 20 v. cut-off bias is switched off. The time relay maintains a time delay in R4 relay operation of 1.5 ± 0.5 sec.

Relay R4 disconnects the rotor of selsyn 31Sn6 from the output of amplifier L2 of unit TsD-44TP and connects phase 3 of the stator winding of the 31Sn5 selsyn for return of the antenna to zero tilt.

The voltage of the 31Sn5 selsyn, acting at the output of the antenna tilt control circuit, starts the tilt motor 31M3 operating toward reduction of voltage at output L2 to zero.

Selsyn 31Sn5 is stabilized in such manner that the zero value voltage of phase 3 of the stator coincides with the zero on the tilt scale. In such manner in switching to the aiming mode the tilt stabilization of the antenna is switched off.

For protection of the tilt reducer during large angular deviations, in the tilt UPT circuit are connected diodes D1 and D2 through the normally closed contacts of relays R1 and R1 and R2. Relays R1 and R2, diodes D1 and D2 and microswitches 31KV5 and 31KV6 of unit Tsd-31TP comprise the circuit for end protection of the tilt reducer.

The tilt magnetic amplifier MU3 is the power amplifier of the tilt channel.

Currents of tilt UPT L4, flowing through its control windings, are the MU control signal.

The feedback voltage from the tach generator 31TG3 is amplified by the UPT feedback L5 and proceeds to the MU3 feedback windings.

The feed of the operating coil of the magnetic amplifier is accomplished by a voltage of 115 v. at 400 cps through the MU3 protective circuit (relay R5 and R6), assuring its feed to the MU only after the bias winding is supplied with a +150 v. voltage.

The protective circuit prevents the magnetic amplifier from going out of operation in the absence of MU bias.

The azimuth and elevation magnetic amplifiers MU1 and MU2 are hooked up in one circuit and are the power amplifiers of the respective channels of azimuth and elevation.

The input signals of the MU1 and MU2 are the UPT currents of the azimuth and elevation channels of the antenna control unit TsD-40TK.

The operating coils and the bias windings of the MU1 and MU2 are fed from the reference transformer unit Tr1.

The feedback voltage from the tack generators 31TG1 and 31TG2 proceed directly to the feedback windings of MU1 and MU2.

Output windings of the magnetic amplifiers are connected to the control windings of the azimuth and elevation motors 31M2 and 31M1.

Section 4. Unit Design

The unit is mounted on the chassis.

The unit is attached to the cage by four screws.

On the front panel of the unit are located monitoring jacks G1 to G12, a cable with plug 2RM42BPN50Sh2V1 and potentiometers R11 ("Balance K") and R2 ("Amplification").

All large dimension components, parts and tubes are positioned in the upper part of the unit chassis and are closed from the top by a lid attached by six screws to the unit chassis.

In the lower part of the chassis is located a set of suspended parts which is also covered with a lid attached to the unit chassis by screws.

S-E-C-R-E-T

Chapter Thirteen

SWEEP UNIT TsD-46

Section 1. General Characteristics of Unit

Unit TsD-6 operates in the scanning and aiming modes and is the sweep unit for brightness indicator TsD-34TPM.

The purpose of the unit is:

1. In the scanning mode, providing B-sweep display on the screen of the indicator making it possible to determine in the Cartesian system the coordinates of the range to the target and the azimuth angle.

2. In the aiming mode, providing on the screen of the indicator a "floating spot" type sweep display in the form of a "bird" making it possible to determine three target coordinates: range, azimuth angle and elevation angle.

3. The shaping of a launch zone pulse, the duration and location of which on the "floating spot" type sweep establish on the indicator screen the zone of permissible firing depending on the speed of approach of the interceptor to the target and on the height at which it is flying.

Section 2. Basic Technical Characteristics of the Unit

In the scanning mode:

1. Intensity pulse of range sweep at jack G15:

duration	T_0 microseconds
amplitude	80 ± 10 v.
polarity	positive

2. Voltage of range sweep:

duration T_o microseconds

3. Voltage of azimuth sweep during the combined operation of units TsD-34TPM and TsD-46.

In the aiming mode:

1. Intensity pulse of range sweep at jack G15:

amplitude 80 ± 10 v.

duration T_p microseconds

polarity positive

2. Voltage of range sweep at jack G12:

amplitude 20 ± 5 v.

duration T p. r. microseconds

3. Pulse of "launch zone" at jack G15:

amplitude 30 ± 5 v.

polarity negative

4. The voltage of the azimuth sweep during the combined operation of units TsD-34TPM and TsD-46 is -30 ± 5 v. to -45 ± 10 v.

5. The voltage of the elevation angle sweep during the combined operation of units TsD-34TPM and TsD-46 is -30 ± 5v. to -45 ± 10 v.

6. Synchronizing pulses and range pulses at the input of the cathode repeater:

amplitude of pulse at jack G2 - 50 ± 10 v.

amplitude of range pulse at jack G1 - 35 ± 5 v.

polarity - positive

S-E-C-R-E-T

7. Synchronizing pulses and range pulses at the output of the cathode repeater at G17:

amplitude of the pulse 14 ± 3 v.

amplitude of the range pulse 14 ± 3 v.

polarity - positive

8. Consumption of unit TsD-46 during the combined operation with unit TsD-34TPM along the circuits:

115 v. 400 cps - no more than 0.7 amps.

+27 v. - not more than 1 amp.

+250 v. stabilized - not more than 0.16 amps.

-250 v. stabilized - not more than 0.02 amps.

115 v. 600 to 900 cps - not more than 1.5 amps.

9. Weight of the unit is not more than 6.5 kg.

Block diagram of the unit is shown on fig. 25. (see catalog of diagrams).

Section 3. Description of Unit Circuit

The following circuits, named according to their corresponding functions, are included in unit TsD-46:

1. The circuit for the shaping of the range sweep and the circuit for the shaping of intensity pulses in the scanning mode (L3, L4, L5).

2. The circuit for the shaping of the azimuth sweep in the scanning and aiming modes D14; D15.

3. The circuit for the shaping of the range sweep in the aiming mode L6; left 1/2 of L7; L8; L9; and L10.

[redacted]

4. The circuit for the shaping of pulses in the "launch" zone in aiming mode L14; L15; and L16.

5. The circuit for the shaping of range sweep intensity pulses in the aiming mode L3 and the left half of L4.

6. The circuit for the shaping of the elevation sweep in the aiming mode D12 and D13.

7. The circuit for the shaping of the zero and present range - right half of L7.

1. The Circuit for the Shaping of the Range Sweep and the Circuit for the Shaping of Intensity Pulses in the Scanning Mode.

The circuit for the shaping of the range sweep is designed for producing the range sweep on the screen of the cathode ray tube 34L1 and consists of the following elements:

a. Sawtooth voltage generator - right half of L4;

b. Sawtooth current generator - L5.

The circuit for the shaping of intensity pulses consists of the intensity multivibrator L3 and the cathode repeater left half of L4 and is intended for the production of pulses intensifying the range sweep. The operation of these circuits proceeds in the following manner.

The intensity multivibrator L3 is triggered by pulses from unit TsD-25TK, successively with a frequency of T_0, and develops a square pulse with a duration of T_0 microseconds of positive and negative polarity.

[redacted]

The positive pulses of the intensity multivibrator through the cathode repeater left half of L4 proceed to the modulator of cathode ray tube TsD-34TPM for intensifying the range sweep.

The amplitude of the intensity pulses, and consequently, also the degree of luminescence of the range sweep are regulated in the TsD-34TPM unit with the help of the potentiometer "Sweep intensity".

The negative pulses of the intensity multivibrator proceed to the input of the sawtooth voltage generator right half of L4.

The sawtooth voltage generator develops positive sawtooth voltage pulses with a pedestal (trapezoidal voltage) required for compensating of the nonlinearity of sweep caused by the transient condition on the spurious capacitance of the deflecting coil.

The trapezoidal voltage pulses proceed to the sawtooth current generator, the anode load of which is the deflecting coil 340K1 (3 - 4), located in the unit TsD-34TPM.

As a result of the simultaneous action of the positive intensity pulse of the range sweep supplied to the modulator of the cathode ray tube 34L1 and the linear sawtooth current passing through the deflecting coil 340K1 (3 - 4), there is produced on the screen of the indicator of unit TsD034TPM a range sweep in the scanning mode in the form of luminant vertical lines (during sufficient amplitude of the intensity pulse). The distance of any point of the range sweep line to its zero is proportional to the distance to the target.

2. The Circuit for the Shaping of the Azimuth Sweep in the Scanning and Aiming Modes

The circuit for the shaping of the azimuth sweep operates in the scanning and aiming modes and is designed for producing:

a. in the scanning mode: a sawtooth voltage of azimuth sweep, under the influence of which the line of the range sweep traverses along the azimuth scale of unit TsD-34TPM in accordance with the movement of the antenna beam in space in the azimuth direction;

b. in the aiming mode: a variable voltage, under the influence of which the "bird" in unit TsD-34TPM traverses on an angle corresponding to the angle of rotation of the antenna beam tracking the target in the azimuth direction.

A change of mode of operation of the circuit is accomplished by the commutation of the input voltage and the output loads. The circuit can be represented as a phase detector incorporating crystal diodes D14 and D15. To the input of the phase detector of the azimuth sweep in the scanning mode simultaneously arrive the reference voltage with a 400 cps frequency from transformer Tr5 and the voltage from the selsyn transmitter 31Sn2 of the same frequency modulated according to the law of the rocking of the antenna. The first voltage proceeds to both diodes D14 and D15 in phase, and the second - in antiphase.

The horizontal deflecting coil 340K (1 - 2) serves as the load of the diodes D14 and D15. The phase detector converts the variable voltage of the azimuth selsyn 31Sn2 into sawtooth voltage of the azimuth sweep. The currents originating in coil 340K1 (1 - 2) excite in it such magnetic fields which produce horizontal movements of the range sweep to the left and to the right relative to the zero of the azimuth scale of unit TsD-34TPM. This movement of the range sweep along the azimuth scale of unit TsD-34TPM corresponds to the movement of antenna TsD-31TP along the azimuth in relation to the longitudinal axis of the airplane.

The left position of the antenna corresponds to the left position of the range sweep on the indicator screen and vice versa.

In the scanning zone in order for the target blip to take form of a solid horizontal line the output voltage is modulated by a T30 frequency voltage of constant amplitude. This voltage is taken from the reference voltage generator (from GON) of unit TsD-31TP and is fed to the output of the azimuth sweep circuit through the contacts of relay R6.

In the aiming mode at the input of the azimuth sweep circuit is connected selsyn 31Sn3 (1:4), the voltage of which changes according to the law of the antenna target tracking beam.

The deflecting coil 340K1 (1 - 2) serves as the load for the azimuth scanning circuit in the aiming mode.

3. The Circuit for the Shaping of the Range Sweep in the Aiming Mode

The circuit for the shaping of the range sweep in the aiming mode is designed for producing sawtooth voltage under the influence of which the cathode ray tube beam moves in a diametrically opposed direction from the center of symmentry of the "bird".

The circuit consists of the following elements:

a. trigger L6;
b. paraphrase amplifier left half of L7;
c. phantastron L8;
d. multivibrator L9;
e. sawtooth current II generator L10, parallel to which is connected the deflecting coil 340K1 (5-6).

The indicator triggering pulses "T_6+5" coming from unit TsD-25TK, in this mode with a frequency of T19 initiates trigger L6 from the output of which are taken negative and positive pulses to the input of the paraphase amplifier left half of L7. From the paraphase amplifier the trigger pulses proceed simultaneously to the differentiating circuits I and II. Positive pulses taken from differentiating circuit I trigger phantastron L8, and the negative pulses taken from differentiating circuit II trigger multivibrator L9. The negative pulses of the phantastron and the positive pulses of the multivibrator proceed to the input of the generator of sawtooth current II. That generator acts as an amplifier with negative feedback (integrator). For this reason it changes the pulses of phantastron L8 and multivibrator L9 from rectangular into trapezoidal. The pulses of such form and opposite polarity are required for producing the left and right range sweeps (left and right "wings" of the "bird") with the help of the deflecting coil connected to the output of the sawtooth current II generator L10.

For matching the start of the left range sweep with the start of the right, to the input of the sawtooth current generator are fed trigger pulses proceeding from the paraphase amplifier left half of L7.

During the presence at the modulator of cathode ray tube 34L1 of unit TsD-34TPM of an intensity pulse of the range sweep in the aiming mode and the presence of range sweep antiphase, trapezoidal pulses at the deflecting coil 340K1 (5-6), on the screen of the indicator there will be lighted up an image in the form of a "bird" with two range sweep "wings", the point of junction of which will be the center symmetry.

4. The Circuit for the Shaping of Pulses in the Launch Zone in the

S-E-C-R-E-T

Aiming Mode.

The circuit for the shaping of pulses in the missile launch zone is designed for producing pulses whose parameters depend on the speed of approach of the intercepting airplane to the target and on the altitude of the intercepting airplane.

The circuit for the shaping of pulses in the launch zone consists of:

a. phantastron D min. L14;
b. phantastron D max. L15;
c. mixer left half of L16;
d. videoamplifier right half of L16;

Phantastron D min. and D max. are triggered by pulses from unit TsD-25TK and develop square pulses with the duration of pulse of phantastron D max. determined by the magnitude of the control voltage, U max., and the duration of the phantastron pulse D min. is constant. Voltage U max. comes from unit TsD-37. Square pulses of phantastrons D min. and D max. proceed to the mixer left half of L16. During this time a positive pulse, which is the difference of the output pulses of phantastrons D min. and D max., is produced at the mixer load. This pulse is called the launch zone pulse.

The magnitude of delay of its leading edge depends on the duration of the D min. phantastron pulse, and the magnitude of delay of its trailing edge - on the duration of the D max. phantastron pulse.

In addition to the launch zone pulse, to the input of the mixer left half of L16 is fed the range pulse from unit TsD-37 for producing an added intensity of the range markers located in the shaded launch zone.

From the output of mixer left half of L16 the positive launch zone pulse with the negative range pulse (or without it) proceeds to the input of the videoamplifier right half of L16, is intensified and already of opposite polarity is fed to the multivibrator of intensifier L3.

5. The Circuit for the Shaping of the Range Sweep Intensity Pulses in the Aiming Mode

The circuit for the shaping of the range sweep intensity pulses in the aiming mode does not differ, in the main, from the intensity circuit in the scanning mode and incorporates the very same tubes L3 and the left half of L4 which perform analogous functions in both modes.

The principle of operation of the circuit for the shaping of the range sweep intensity pulses in the aiming mode consists of the following.

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

The L3 intensifier multivibrator in this mode is triggered, in distinction from the scanning mode, by T_o pulses coming from the TsD-25TK unit with a frequancy of T19. At the output of the multivibrator, in addition to the multivibrator's own pulse, there is also produced a launch zone pulse with a range or without it, proceeding from L16. Such a composite pulse is fed to the modulator of the cathode ray tube L1 of unit TsD-34TPM through the intensity pulse cathode repeater left half of L4. Owing to the presence of the launch zone pulse, decreasing the amplitude of the intensity pulse and thereby cutting off tube 34L1, not the entire range sweep of the aiming mode is intensified. The dimension of illuminated sections depends on the duration of the launch zone pulse and, consequently, on the speed of approach to the target and on the altitude of the interceptor.

6. The Circuit for the Shaping of the Elevation Sweep in the Aiming Mode

The circuit for the shaping of the elevation sweep operates only in the aiming mode and is designed for producing a variable voltage under the influence of which the "bird" of unit TsD-34TPM changes in angle corresponding to the angle of rotation of the antenna tracking the target for elevation.

This circuit consists of a phase detector incorporating crystal diodes D12 and D13. At the input of the phase detector there arrive simultaneously reference voltage with a frequency of 400 cps from transformer Tr3 and voltage from selsyn 31Sn1 (1:4). The first voltage goes to both diodes D12 and D13 in phase, the second - in antiphase.

Since the circuit for the shaping of the elevation sweep does not differ from the circuit for the shaping of the azimuth sweep is fed to the vertical deflecting coil 340K1 (3 - 4) of unit TsD-34TPM.

7. The Circuit for the Shaping of the Zero Markers and the Present Range

The circuit for the shaping of the zero range markers ("marker") and the present range incorporates the right half of L7 and consists of a cathode repeater, the load of which is the vertical deflecting coil 340K2 (10 - 11) of unit TsD-34TPM.

The pulses from unit TsD-25TK and the range pulses from unit TsD-37 proceed to the output of the cathode repeater.

The tracking frequency of these and other pulses is equal to T19. Passing through coil 340K2 (10 - 11), these pulses cause a vertical (upwards) deflection of the ray of the tube.

The deflection of the beam occurs at the start of the sweep, that is, at zero range through the action of the synchronized pulses, and in the remaining points of sweep - through the action of the range pulses.

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

sweep corresponding in time with the synchronized pulses and range pulses to be visible to the eye, it is necessary to increase the intensity voltage.

This increase is accomplished by means of supplying those very same pulses of negative polarity amplified by videoamplifier 34L2 to the cathode of the cathode ray tube 34L1.

Section 4. Design of the Unit.

In construction the unit consists of the following components: (a) chassis; (b) front panel; (c) housing.

The aluminum chassis is the basic design component on which are located all elements.

On the front panel of the unit there are slotted control shafts for the following elements of the circuit:

(a) "Yark. mark." (Mark. Brightness); (b) "Ampl."; (c) "Simmetr.I" (Symmetry I); (d) "Skhodim. otm." (Marker Convergence); (e) "Simmetr. II" (Symmetry II); (f) "Napr. GON" (Reference Generator Voltage).

On the front panel of the unit there are also located 18 monitoring jacks G1 to G18 and a high frequency socket F7.

Unit demensions: 257.5 x 321 x 126 mm.

The unit is mounted on Shock absorbers.

S-E-C-R-E-T

50X1-HUM

Chapter Fourteen

INDICATOR TSD-34TPM

Section 1. General Characteristics of the Unit

Unit TsD-34TPM is a combined indicator of detection and aiming, with the aid of which it is possible to determine visually a target by inclination, azimuth, and distance to the target in modes of scanning and aiming. Unit TsD-34TPM operates together with sweep unit TsD-46 and creates in scanning mode sweep of type B (range - azimuth) with addition of rough indication of elevation.

In this mode, the target on the screen of the indicator is represented in the form of a horizontal line with vertical markings of the upper or lower hemisphere indicating in which hemisphere the target is located.

At the moment of lock-on by range from relay 42R6 of the automatic lock on there is fed + 27 v dc to relays R1, R2, R3, R4, R5. They operate and the unit is switched to aiming mode.

In aiming mode on the screen of unit TsD-34TPM, there is created a sweep of "floating spot" type in the form of a "bird" with two symmetrical range sweeps.

On the range sweeps ("bird") in the center of symmetry there are vertical marks with the aid of which is determined the range to the target. The position of the center of symmetry of the "bird" reflects the angle coordinates of target (azimuth and elevation) relative to the interceptor aircraft.

The mark found in the center of the "bird" located at the beginning of the left and right range sweeps is called the mark of zero range, or marker.

The markings found on the "bird" are called present range marks. The interval between zero range mark and any (right or left) current range mark is proportional to the distance to the target.

For indicating permissible firing zones on the range marks, there are nonluminous sections of the firing zone. Unit TsD-34TPM shows dangerous closing range and noise interference.

Section 2. Basic Technical Characteristics

In scanning mode:

1. Length of raster - 80 ± 8 mm
2. Width of raster 50 ± 5 mm

50X1-HUM

3. Accuracy of calibration of scanning of range $0.5 \div 1$ km.

In Aiming mode:

1. Limit of determining range 0° - D_z;
2. Tracking angles in azimuth plan and elevation plane $\pm 10^{\circ}$.
3. Length of left and right range sweeps 36 mm.
4. Size of zero range mark $4 \div 10$ mm
5. Size of present range marks from $2 \div 5$ mm.

For assuring normal operation the input of unit receives:

In scanning mode:
Range sweep intensity pulses:

a. Amplitude $80 \div 10$ v
b. Polarity - positive.

Target pulses:

a. Amplitude $20 \div 5$
b. Polarity - positive.

"Top" marker pulses

a. Amplitude $20 \div 5$ v
b. Duration $3.5 \div 6$ microseconds
c. Polarity - positive

"Bottom" marker pulses:

a. Amplitude $20 \div 5$ v
b. Duration 3.5 ∓ 6 microseconds
c. Polarity - positive

Diagram of unit is in Figure 26 (see diagram book).

Section 3. Circuit Description

In the unit there is used a storage CRT with visible image, the design and principle of operation of which differs from the ordinary tubes. The tube is intended for the conversion of an electrical signal into a visible image of great intensity. The image on the screen is preserved after cessation of the incoming signal for a definite period of time, which it is possible to control within the limits ranging from a fraction of a second to several seconds.

S-E-C-R-E-T

50X1-HUM

[redacted]

The great brightness of the image permits use of this CRT type under conditions of great illumination.

a. The Process of Recording and Reproducing the Image in the Mode of Scanning

The unit input in this mode receives from unit TsD-46:

a) Intensity pulses
b) Target pulses, pulses of "Top-Bottom" markers
c) Range sweep voltage
d) Azimuth sweep voltage

The positive intensity pulses proceed to a divider, consisting of resistor R3 and potentiometer R4 "Sweep intensity". The intensity pulses taken from the slide of potentiometer R4 proceed through closed contacts 8, 7 of relay R3 and capacitor C5 to modulator 1 of the CRT L1.

The amplitude of pulses, taken from resistor R4, is established with so that the recording projector opens only at the moments of coincidence of positive intensity pulses of great duration fed to the modulator of the CRT, and negative target pulses and "Top-Bottom" markers of short duration, fed to its cathode. Target and "Top-Bottom" pulses at the unit input have positive polarity. Change of their polarity takes place in unit TsD-34TPM.

Thus, the recording projector will be opened only for the duration of pulses (target and "Top-Bottom"), fed to the cathode of the CRT L1. The amplitude of the intensity pulse depends on the voltage at CRT modulator, established with aid of potentiometer R16 "Aim brightness".

For the creation of negative video pulses of the target and "Top-Bottom" marks positive video pulses are fed with frequency T9 to 7Sh4T-1.

From 7Sh4T-1, they proceed to the input of video amplifier right half L2, are amplified by it and with negative polarity are taken from its output to the cathode of the recording projector of tube L1. At this moment, the CRT is opened by the recording projector, i.e., the recording beam appears.

Erasing pulses are formed by the blocking-oscillator for erasing pulses left half L2, operating in scanning and aiming modes. This oscillator is a self-excitation oscillator. Since in aiming mode the image brightness is greater than the image brightness in scanning mode, for erasing the image in aiming mode it is necessary to assure a high repetition rate of erasing pulses.

A considerable change in the erasing pulse repetition rate (some 100 times) when switching from scanning mode to aiming mode is accomplished by changing the mode of operation of the blocking-oscillator.

S-E-C-R-E-T

[redacted]

b. The Process of Recording and Reproducing the Image in the Aiming Mode

a. Intensity pulses;
b. Range pulses and synchropulses;
c. Range sweep voltage;
d. Azimuthal sweep voltages;
e. Elevation sweep voltages.

The intensity in this mode, as in the scanning mode, proceed to the modulator of the recording projector of the CRT. Due to complex form of the intensity pulse the recording projector is opened only when the amplitude of the intensity pulse exceeds the blocking voltage (period t_0t_1 and t_2-t_3). In the period of action (period t_1-t_2) of the negative pulse of the firing zone, which reduces the amplitude of the intensity pulse the recording beam is absent and recording of the image does not take place.

c. Erasing the Image of the "Bird" When Changing From Aiming to the Scanning Mode

When switching from aiming to scanning mode, there is sharp reduction in the frequency of the erasing pulses; therefore, the image of the "bird", recorded in the aiming mode is for a long time not erased. To speed up erasing of the "bird" in this case in the unit, there is automatic instantaneous erasing by a circuit consisting of relay R7, resistor R52, and capacitor C12.

The principle of erasing consists in the following. In the aiming mode, relay R5 operates and capacitor C12, through closing contacts 4, 5 of relay R5 and resistor R52, is charged to source voltage + 250 v st. Upon switching of unit TsD-34TPM to scanning mode relay R5 releases its contacts 4,5, and contacts 4,3 close and connect capacitor C12 in parallel with relay R7. Relay R7 operates, contacts 3,5 close, which is tantamount to pressing the "instantaneous erase" button; thereupon, the target of the tube receives a voltage + 25 v, taken from resistors R8, R28, of the divider of source voltage + 250 v st, R5 - R7, R28, R8. According to the degree of discharge of capacitor C12 relay R7 releases and rapid erasing ceases.

Description of Circuit and Design of High-Voltage Rectifier VV7

Supply of the CRT with high voltage is accomplished from a high-voltage rectifier for 1.2 kv and 6.5 kv, which is an independent component of TsD-34TPM.

The rectifier is switched on by contacts 6, 7 of relay R6, which operates off of -250 v st. This is necessary for prevention of breakdown of the tube on +6.5 kv, since rectifier VV7 when idling (with unwarmed tube cathode) develops voltage up to + 10 kv.

50X1-HUM

The CRT's + 6.5-kv high-voltage supply is a sixfold voltage multiplier, supplied 115 v 400 cycles, collected on six multiplication stages. Each multiplication stage consists of a selenium rectifier and capacitor. Besides this, the circuit employs a step-up transformer, due to which at the multiplier input (the secondary winding of the transformer) there is alternating voltage U_2 about 1/2 kv 400 cycles, with the transformer primary receiving voltage U_1 of 115 v 400 cycles.

In order that voltage at the rectifier output vary less with variation of the current, required by the tube, the rectifier loaded on two parallel-connected resistors R2 and R3 at 100 mohm each. The current required by R2, R3 is much more than the current required by the tube; therefore, during variation of current of the screen, voltage at the output of the rectifier varies, within small limits.

Filtration of the alternating component is accomplised with filter R1, C9. The primary winding of the step-up transformer has taps for selection of the transformation ratio.

The rectifier for CRT supply with -1.2 kv is based on voltage doubling scheme.

Intensity and Signalling Circuits

With achievement by the interceptor aircraft of dangerous range the lamp "O", from unit TsD-37 through unit TsD-42 and TsD-46 is fed + 27 v and goes on.

In the presence of noise interference of sufficient magnitude, unit TsD-26TK gives out voltage + 27 v to lamp "P" through units TsD-42 and TsD-46. Lamp "P" burns, after which the pilot must change over to "Interference mode. Lamps LN4, LN5, LN6, LN7 serves for illuminating the scale and the "instantaneous erase" signal. Brightness intensity is regulated by potentiometer R32 "Podsvet" (intensity).

Section 4. TsD-34TPM Construction

The unit TsD-34TPM is a welded aluminum chassis, arranged in a case and secured with screw latches. The whole unit is installed on a shock-mounted frame with four shock absorbers and secured to the frame by two bolts, coming out on the forward panel.

The unit consists of the following components:

50X1-HUM

a. Frame
b. Forward panel
c. Case

The frame is the main connecting element, assuring rigidity of the unit. On the back wall of the frame is a plug connector.

On the forward panel are located the following control and monitoring elements;

a. Regulation of brightness in the scanning mode "Brightness" R4;
b. Regulation of beam focusing "Focus" R19;
c. Regulation of intensity of the indicator scale "Intensity" R32;
d. Dial lights LN4 LN7 (SM36)
e. Forward panel lights LN1 LN2;
f. "O" lamp LN3;
g. "P" lamp LN8;
h. "Instant Erase" button (KN1);
i. Monitoring jacks for various sections of the unit G1-G3.

Control elements on the frame:

a. Shifting "bird" on vertical - "Vert. shift. of aim" R23
b. Shifting "bird" on horizontal - "Horiz. shift. of aim" R27
c. Shifting range sweep in scan on horizontal "Horiz. shift. of scanning" R26
d. Vertical shift of center in scanning mode "Vert. shift. of scanning" R13.
e. Regulation of brightness in aim mode "Brightness of aim" R16
f. Regulation of amplitude of erasing pulses in scanning mode "Memory of scan" R38
g. Regulation of amplitude of erasing pulses in aiming mode "Memory of aiming" 39
h. Regulation of frequency of erasing pulses in scanning mode "Frequency of erasing pulses" R36

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

Chapter Fifteen

TsD-26TK NOISE INTERFERENCE INDICATOR UNIT

Section 1. General Characteristics

The TsD-26TK unit provides:

a) indication of smooth noise interference;
b) ShARU widegate formation in "Interference" mode;
c) artificial target pulse formation during ShARU widegate in "Interference" mode;
d) monitor gate formation in "Monitoring" mode;
e) supply of switch-on command for interference automatic tracking after setting the antenna mirror on DU;
f) supply of command to automatic lock-on relay in "Interference" mode;
g) supply of command to noise interference automatic tracking relay;
h) supply of command for range search switch-on and switch-off in unit TsD-37 in noise interference automatic tracking mode.

Section 2. Basic Technical Characteristics

1. Artificial target pulse in "Interference" mode:

   a) amplitude 30-40 v

2. Artificial target pulse in "monitoring" mode;

   a) amplitude 30-40 v.

3. ShARU wide gate in "Interference" mode:

   a) 65-80 v

4. Circuit demand:

   a) 115 v, 600-900 cps, not more than 0.6a
   b) + 27 v, not more than 0.2a
   c) +300 v stab; not more than 55 ma
   d) +150 v stab; not more than 40 ma
   e) - 250 v stab; not more than 30 ma

5. Unit weight, not more than 3 kg

6. Unit dimensions, 114 x 378 x 138 mm

Circuit is shown in Fig 27 (book of diagrams).

Section 3. System Description

This consists of the following functional systems:

1) noise interference indicator circuit;
2) ShARU wide gate forming circuit;
3) Artificial target forming circuit.

1. Noise Interference Indicator Circuit

The circuit includes;

a) coincidence stage LI;
b) ShARU gate limiter, left half L2;
c) amplifier, right half L2;
d) multivibrator L3;
e) cathode follower, left half L9;
f) pulse counter, right half L4 and left half L5; DI; C6, C12;
g) automatic interference indicator, right half L5.

The coincidence stage L1 receives noise interference pulses. Simultaneously , through ShARU gate limiter, left half L2, to the coincidence stage if fed a ShARU narrow or wide gate. Upon coincidence in time of these signals at the output of the coincidence stage L1 a negative pulse is separated, amplified by the right half of L2. Positive amplified pulse from right half of L2 triggers multivibrator L3.

From load of multivibrator L3, across cathode follower left half L9, multivibrator pulses are fed to right half L4, left half L5, C6, C12, Di. With passage of say 10 pulses with repetition rate, voltage across the capacitor reaches a value at which current of left half L5 causes relay R1, connected into its plate circuit, to function.

Across the closed R1 contacts +150 v stab. opens the automatic interference indicator right half L5. Plate current of right half L5 causes relay R2 to function.

Across closed R2 contacts +27 v goes to TsD-34TPM for "P" light and to TsD-41TPM to operating mode switch in "Interference" position.

S-E-C-R-E-T

50X1-HUM

2. ShARU Wide Gate Forming Circuit

The circuit includes:

a) delay phantastron L6 with cathode follower right half L7;
b) blocking oscillator L8;
c) cathode follower left half L7.

In "Interference" mode unit TsD-25TK supplies a sync pulse to trigger delay phantastron L6. Negative pulse from the phantastron is differentiated. A positive pulse corresponding to trailing edge of phantastron pulse triggers blocking oscillator L8. ShARU wide gate positive pulse, across cathode follower left half L7, goes to TsD-33 for gating the receiver and to TsD-26TK for noise interference indicating circuit instead of ShARU narrow gate.

3. Artificial Target Forming Circuit

a) In "Interference" Mode

In the "Interference Mode amplifier L10 of the artificial target forming circuit receives + 150 v stab. plate voltage. Amplifier input gets smooth noise interference pulses coincident in time with ShARU wide gate. The noise interference pulses are amplified by two-stage amplifier and are differentiated.

The positive differentiated pulse triggers artificial target blocking oscillator L11. From L11 output, artificial target positive pulses, in "Interference" mode, is fed to TsD-25TK.

b) In "Monitoring" Mode (formation of monitor gate)

The monitor gate forming circuit includes:

a) delay phantastron L6 with cathode follower right half L7;
b) blocking oscillator L8;
c) Blocking oscillator L11.

In "monitoring" mode relay R9 operates and across its closed contacts 4, 5 a transmitter triggering pulse is sent from TsD-36 to delay phantastron L6 trigger.

In this mode the phantastron generates a 15 microsec pulse. Negative phantastron pulse is differentiated and a positive pulse triggers ShARU gate blocking oscillator L8. ShARU gate blocking oscillator positive pulse,

50X1-HUM

across R9 closed contacts 7, 6 goes to artificial target blocking oscillator L11 trigger. From L11 output the artificial target pulse--monitor gate--goes to TsD-32 for triggering the transmitter in the "monitoring" mode.

4. Circuit for Switching on Interference Automatic Tracking and Switching on Range Search

The circuit's purpose is to switch on interference automatic tracking when the antenna mirror with respect to azimuth is set at zero. The circuit uses the right half of L9. In scan mode right half L9 is blocked by -200 v stab. In the DU-250 v stab. blocking voltage is taken from the circuit by supplying the "ground" from TsD-42. The circuit input receives voltage from azimuth selsyn 31Sn3. When voltage from the selsyn drops to 7 plus or minus 2 volts, right half L9 is opened and operates relay R3.

Closed R3 contacts 6, 7 cause relay R5 to operate, and also in "interference" mode ground the winding of the automatic tracking relay in TsD-42. When R5 operates closed contacts 4, 5 ground the winding of interference automatic tracking relay in TsD-42.

When the "Zakhvat" button is pressed + 27 v goes to winding of relay R7 which, by operating, removes negative blocking voltage from screen grid of tube L13 in unit 37, cutting in range search.

In "interference" mode + 27 volts does not go to winding of relay R7.

Section 4. Unit Construction

The unit consists of:

a) sectional frame;
b) horizontal panel;
c) case.

The frame connects all unit components and a side wall has retained bolts for securing the unit to the radar yoke.

The horizontal panel has on it:

a) vacuum tubes;
b) transformers;
c) adjusting capacitors;
d) relays
e) monitoring points

50X1-HUM

Under the horizontal panel are cable forms with assembly components.

The frame contains:

a) potentiometers;
b) monitoring jacks;
c) plug connector;
d) radio-frequency plug.

The unit is secured in the container by four screws.

Unit dimensions are 114 x 378 x 138 mm.

S-E-C-R-E-T

50X1-HUM

Chapter Sixteen

POWER SUPPLY UNIT TsD-38

Section 1. General Characteristics

TsD-38 is designed to supply the radar with stablized voltage + 150 v stab; + 250 v stab; + 300 v stab; -250 v stab.

With respect to functions the unit can be broken down into the following circuits:

1) + 150 v stabilized rectifier;
2) + 300 v stabilized rectifier;
3) + 250 v stabilized rectifier;
4) -250 v stabilized rectifier.

Section 2. Basic Technical Characteristics

1. Unit is supplied from AC sources:

   115 v, 600-900 cps and 115 v, 400 cps.

2. Current required from AC source:

   115 v, 600-900 cps not more than 6a;

   115 v, 400 cps not more than 0.6a.

3. Nominal voltages at output:

   a) + 150 v stab. at load current 225 ma and source voltage 115 v, 600-900 cps must be 150 plus or minus 2 v;

   b) + 300 v stab. at load current 75 ma and source voltage 115v, 600-900 cps must be 300 plus or minus 3 v;

   c) + 250 v stab. at load current 585 ma and source voltage 115 v, 600-900 cps must be 250 plus or minus 2 v;

   d) -250 v stab. at load current 200 ma and source voltage 115 v, 600-900 cps must be 250 plus or minus 2 v.

[redacted]

4. Stability of output voltage under source voltage (115 v, 600-900 cps) variation of plus or minus 4.5 v, at rectifier output, must be;

a) for +150 v stab. - plus or minus 1.5 v
b) for + 300 v stab. - plus or minus 1.5 v
c) for + 250 v stab. - plus or minus 1.25 v
d) for -250 v stab. - plus or minus 1.25 v

5. Alternating component at rectifier output:

a) +150 v stab. - 50 mv maximum
b) +300 v stab. - 15 mv maximum
c) +250 v stab. - 45 mv maximum
d) -250 v stab. - 35 mv maximum.

6. Magnitude of output voltage of stabilized rectifiers "+150 v stab.", "+300 v stab.", "+250 v stab." and "-250 v stab." must be regulated within limits of no less than plus or minus 5 v under nominal load currents and at source voltage of 115 v, 600-900 cps. The unit diagram is in Fig 28 (see book).

Section 3. Unit System

TsD-38 contains four stabilized rectifiers. To increase line voltage and produce tube filament voltage there are in the unit two transformers Tr1-plate, and Tr-2-plate filament.

The stabilized rectifiers consist Of:

a) rectifiers designed for AC rectification:

" +150 v stab." - D1-D8
" +300 v stab." - D9-D16
" +250 v stab." - D17-D24
" -250 v stab." - D25-D32

b) Smoothing filters at the rectifier output:

" +150 v stab." C1
" +300 v stab." C3
" +250 v stab." C4, Dr1, C5
" -250 v stab." C6

S-E-C-R-E-T

[redacted]

c) Regulating elements resistance magnitudes of which vary in relation to change of input voltage or load current:

" +150 v stab." - L1, L2
" +300 v stab." - L3
" +250 v stab." - L4, L9
" -250 v stab." - L10, L11

d) DC amplifiers designed to amplify variations of output voltage in the circuit:

" +150 v stab." - L12
" +300 v stab." - L13
" +250 v stab." - L14
" -250 v stab." - L15

e) Source of reference voltage is at tube L16.

When unit is switched on 115 v 600-900 cps voltage is supplied to Tr2 and Tr1 after relay R2 operates.

From Tr2 output voltage flows to rectifier "-250 v stab." and to filaments of all tubes in the unit,

After voltage appears at output of "-250 v stab." rectifier relay R1 operates; across its contacts voltage is fed to relay R2 and 115 v, 600-900 cps goes to Tr1 transformer. From Tr1 output voltage goes to rectifiers "+ 150 v stab.", "+ 300 v stab." and "+ 250 v stab."

Section 4. Unit Construction

Unit is mounted on two rectangular frames in a housing.

On unit's front panel are:

1. Seven [sic] monitoring jacks labelled: "+ 150 v", "+ 300 v", "+ 250 v", "-250 v", "I", and "~ 115 v 400 cps."

2. Fuses labelled: "0.25 a, + 150 v"; "0.15 a, + 300 v"; "1a, + 250 v"; "0.25a, - 250 v".

S-E-C-R-E-T

50X1-HUM

3. Slots of potentiometers for regulating voltage at output of stabilized rectifiers "+150 v st.", " +300 v st.", "+250 v st.", "-250 v st."

4. Plate showing unit designation and plant number, cable with plug connector.

On top, of the first frame are transformers Tr1 and Tr2, choke coil Dr1, tubes L1-L16 and ventilator M1. Assembly parts are below.

The second frame holds plates with assembly parts, the capacitors of the filters. The two frames are connected by two hinges permitting them to be opened.

S-E-C-R-E-T

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

50X1-HUM

Chapter Seventeen

CONTROL PANEL TsD-41UTPM

Section 1. Purpose

The TsD-41UTP unit is designed to control the radar both in flight and on the ground.

The elements of control and monitoring on the front panel of the unit makes it possible to carry out:

a. Preliminary ("St. Vkl." - radar on) and complete switching on of a set ("Vys. vkl." higher voltage on);

b. Switching operating modes (Pomekha" - "Soprov." -"Zakr. luch.");

c. Shifting of high-frequency energy of the radar transmitter from antenna equivalent to radiation and switching on of the "Kontrol'" mode by toggle switch "Izluch. - Ekvival. Kontr.";

d. Control of radiation of high-frequency energy.

The TsD-41UTPM unit is attached in the cabin of the airplane above the instrument panel.

Section 2. Basic Technical Data

1. Weight of the unit - 0.4 kg
2. Size of the unit (without taking into account the length of the connecting cable) - 98 x 56 x 75 mm

A diagram of the unit is provided in Fig 29 (see diagram book).

Section 3. Unit Description

When set is switched on, the TsD-41UTPM sends: "ground" voltage through toggle switch V1 to contactor 42R11 which turns on set. When high voltage is switched on, additional voltage of +27 v is supplied from high-voltage relay 42R25 to unit TsD-42 through toggle switch V1 and from it to the high-voltage relay in unit TsD-32TK.

50X1-HUM

50X1-HUM

In the "locked-on beam" mode, "ground" voltage is sent from toggle switch V2 to the windings of automatic lock-on relays 42R6, 42R6-1 in unit TsD-32TK.

When toggle switch V2 is set in the "Soprov." and "Pomekha" position, "ground" voltage is sent from toggle switch V2 to automatic tracking relays 40R1, 40R2 in unit TsD-26TK.

Simultaneously in the "Pomekha" mode, + 27 v is sent from unit TsD-26TK through toggle switch V2 to the windings of "Pomekha" relays 42R20, 42R20-1 in unit TsD-42 after the automatic noise indicator triggers.

In the "Izluch." position, + 27v is sent to unit TsD-29TPM through toggle switch V3 to switch the wave-guide switch to the position for radiation of high-frequency energy of the transmitter to the antenna of the set. If high voltage is present, + 27 v is sent from the radiation monitoring relay in unit TsD-42 to signal lamp IN2 in control panel TsD-41UTPM. When toggle switch V3 is set in the "Kontr." position, + 27 v is sent to Unit TsD-42 to turn on the monitoring circuit.

Lamp IN1 serves to illuminate the inscriptions on the front panel of unit TsD-41UTPM.

Section 4. Unit Construction

The unit is constructed in the form of a box-type chassis. The front panel is attached to one side of the chassis, and "toggle switch" type control switches, the signal light for radiation, and the lamp for illuminating inscriptions are located on it. Inscriptions are made on plexiglas which is mounted between the front panel and the chassis, and are viewed through rectangular slots in the front panel.

A connecting cable with an RM-type plug at the end runs from the chassis. The unit is closed by a housing.

S-E-C-R-E-T

50X1-HUM

Chapter Eighteen

MONITORING PANEL TsD-41KTP

Section 1. Purpose

Unit TsD-41KTP is designed to monitor:

a. magnetron current;
b. crystal currents;
c. pressure in the pressurized system of the set.

Unit TsD-41KTP is located on the left side of the airplane.

Section 2. Basic Technical Data

Voltages proportional to the magnetron current, the crystal currents, and the pressure inside the pressurized system of the set are sent from unit TsD-32TK to the voltmeter of unit TsD-41KTP.

1. The unit provides:

a. When switch V1 is set in the "TM" position, reading of the instrument in graduations corresponds to the magnetron pulse current in amperes (16-22) with an error of no more than ± 2 graduations.

b. when switch V1 is set in the "TK-1," "TK-2,"or "TK-3" position, the reading of the instrument is equal to 10 ± 1 graduation at crystal currents of 1 ma.

c. when switch V1 is set in the "KD" position:

- reading of the instrument at 20-22 graduations when pressure in the pressurized system of the set is approximately 760 mm and the aircraft electrical network voltage is +27 v;

- a decrease in the reading of the instrument by 3 ± 1 graduations with respect to reading of the instrument at normal atmospheric pressure when there is a pressure decrease in the pressurized system up to 0.25 atm.

1. Weight of unit - 0.75 kg
2. Size of unit (without taking into account the length of the connecting cable) - 135 x 78 x 70 mm.

A diagram of the unit is shown on Fig 30 (see diagram book).

Section 3. Unit System

The voltmeter of the unit is switched in to the blade contact of the wafer switch. Voltages proportional to the magnetron current, crystal currents, and pressure in the pressurized system are supplied to the remaining contacts. When the wafer switch is switched, these voltages are supplied to the voltmeter terminal.

Resistors R6, R3, and R7 are range-multiplying resistors of the voltmeter and are selected when the unit is tuned: R6 for monitoring the magnetron current, R3 for monitoring crystal currents, and R7 for monitoring pressure.

Thermal resistor R5 compensates changes in the resistance of the loop of the voltmeter when the environmental temperature changes. Lamps L1, L2 illuminate the scale of the instrument, lamp L3 illuminates the inscriptions on the front panel of the unit.

Section 4. Unit Construction

The unit is constructed in the form of a rectangular box. The front panel is attached to one side of the chassis, and the voltmeter, wafer switch, and illuminating lamps are located on it. All components of the unit are located on the wiring panel attached to the chassis. A connecting cable with a type "RM" plug on the end runs from the chassis. The unit is enclosed by a housing.

Chapter Nineteen

JUNCTION BOX TsD-42

Section 1. Purpose

Unit TsD-42 connects electrically the units of the set, and also units which are not part of the set but operate with it or monitor its operation. Besides this, a number of commutations connected with turning on the set, turning on high voltage, turning on radiation to the antenna, turning on different modes of operation of the set, turning on the photographic equipment, and finally, turning on the ground control mode are carried out in the unit.

Section 2. Connection of Unit TsD-42 With Other Units

Connection of unit TsD-42 with units of the set and with other units which ensure its operation and monitoring can be shown by the following table:

Pos. no	No. of pins in unit TsD-42	No. of cable in unit TsD-42	Connecting unit	Notes
1	2	3	4	5
1	Sh1	1	TsD-31TP	
2	Sh2	2	TsD-32TK	
3	Sh3	3	TsD-33	
4	Sh6	6	TsD-36	
5	Sh7	7	TsD-37	
6	Sh10	10	TsD-40TK	
7	Sh14	14	TsD-44TP	
8	Sh15	-	TsD-48	cable enters unit TsD-48TP
9	Sh16	--	TsD-48	
10	Sh19	-	TsD-46, VTsD-30, 1186A	units are connected by a special cable
11	Sh20	-	TsD-41KTP, TsD-41UTPM, PT-500Ts, DVS, PO-1500, SGO-8, 27 v (aircraft electrical network)	units are connected by special cable

S-E-C-R-E-T

Pos.No	No.of pins in unit TsD-42	No. of cable in unit TsD-42	Connecting unit	Notes
12.	Sh25	25	TsD-25TK	
13	Sh26	26	TsD-26TK	
14	Sh29	29	TsD-29TPM	

Section 3. Basic Technical Data

1. The thermal time delay relay in the unit cuts in high voltage within 3-4 minutes after complete switching on of the set.

2. Unit TsD-42 sends 400 cps voltage to unit TsD-40TK, which is required for setting the equisignal direction of the set (the antenna reflector) with respect to the azimuth at the required angle to the structural axis of the airplane. This direction is controlled by potentiometer "Nul A" when sighting the radar.

a. Unit TsD-42 sends 400 cps voltage to unit TsD-40TK which is necessary to set the antenna reflector with respect to elevation. This voltage is controlled by potentiometer "Nul N" when sighting the radar.

3. Currents required by the unit do not exceed:

a. 0.3 a for the 115 v 400 cps circuit,
b. 2 a for the 27 v circuit,
c. 8 ma for the+250 v circuit,
d. 5 ma for the-250 v circuit.

4. Weight of the unit - 8.5 kg.

5. Size of the unit (without taking into account the length of the connecting cables) - 330 x 240 x 77 mm. Diagram of the unit, Fig 31.

Section 4. Description of Unit System; Switching on the Supply Voltage

The aircraft electrical circuit voltage of + 27 v is sent to contacts 1 and A of contractor R11 through pin 36Sh20.

When the set is switched on, "ground" voltage is sent to contact B of contactor R11 from toggle switch "Vkl. St." to unit TsD-41UTPM through pin 2Sh20, or from toggle switch "St. Vk." to unit TsD-46 through pin 4Sh15.

Contactor R11 triggers, and the aircraft circuit voltage of +27 v is sent through its contacts and fuse Pr8 to the wiring panel of the unit, and through fuse Pr16, resistors R1 and R2, normally closed contacts 4, 5 of relay R4, pin 4Sh2 to unit TsD-32K to supply the modulator tube filaments and the pressure data unit. Voltage of +27 v passes to the master relay from contact Zh20 of the witing panel through pin 41Sh20; after it drops, the following are sent to the unit:

- 115 v 400 cps through pin 4Sh20, 25Sh20 for one phase, and 5Sh20, 24Sh20, for the other phase;

- 115 v 600-900 cps through pins 1Sh20, 8Sh20 for one phase, and 9Sh20, 13Sh20, for the other phase;

- 36 v 400 cps through pin 21Sh20 (first phase), 22Sh20 (second phase), 23Sh20 (third phase).

A list of the fuses in unit TsD-42 and radar components in which power passes through these fuses is given below:

- 42Pr1 in the 115 v 400 cps supply circuit of the following radar components: the power transformer of unit TsD-40TK; the power windings of the elevation motor 31M1; azimuth motor 31M2 and tilt motor 31M3; rotors of the elevation selsyn 31SN1, azimuth selsyn 31SN3, azimuthal sweep selsyn 31SN2, circuit 31Sn5, for setting the antenna at zero with respect to tilt in the locked-on beam mode and automatic tracking mode, magnetic amplifiers for the azimuth, elevation and tilt in unit TsD-44TP; phase detector for the "Verkh-Niz" marker channel in unit TsD-36; phase detector of the sweep with respect to elevation azimuth in unit TsD-46. Besides this, this voltage is used in unit TsD-48 for monitoring;

- 42Pr2 in the 115 v 400 cps supply circuit of the following set elements: power transformer 32Tr1-3, rectifiers 1400 v - 900 v of the modulator of unit TsD-32TK (additionally through fuse 42Pr13); circuits of fuse 42Pr6;

- 42Pr3 in the 115 v 600 - 900 cps supply circuit of transformer 32Tr-2-2 (filament of the high-voltage kenotrons);

- 42Pr4 in the 115 v 400 cps supply circuit of high-voltage transformer 32Tr-1;

- 42Pr5 in the 115 v 600 - 900 cps supply circuit of filament transformer 32Tr5-1 of tubes FUPCh, APChK, and klystron;

- 42Pr6 in the 115 v 400 cps supply circuit for the filament transformer of magnetron 32Tr2-3 (additionally through fuses 42Pr2 and 42Pr3);

S-E-C-R-E-T

- 42Pr7 in the 115 v 600 - 900 cps supply circuit of the following radar components: the filament transformers of units TsD-25TK; TsD-26TK; TsD-33; TsD-36; TsD-37.

Besides this, this voltage is sent to unit TsD-48 for monitoring;

- 42Pr8 in the +27 v supply circuit

- 42Pr13 in the 115 v 400 cps supply circuits of the following radar components:

- circuits of fuse 42Pr2;

- thermal time delay relay (42R2) in unit TsD-42;

- modulator fan motor of unit TsD-32TK;

- fan motor of unit TsD-38;

- filament transformer of unit TsD-34TPM.

Besides this, 115 v 400 cps is sent to unit TsD-48 for monitoring:

- 42Pr14 in the 115 v 400 cps supply circuit of the transformer for setting the antenna and "bird" (42Tr1) in unit TsD-42.

- 42Pr15 in 115 v 600 - 900 cps supply circuits of the following radar components:

- power transformers of all rectifiers of unit TsD-38;

- filament transformer of unit TsD-46.

- 42Pr16 in +27 v supply circuit of the tube modulator filaments, pressure data unit of relay 32R2-1 for cutting in voltage in unit TsD-32TK.

Switching on High Voltage

A voltage of 115 v 400 cps is sent from pin 25Sh20 through fuse Pr13 and contact E25 of the wiring panel to contact 1 of the windings of time relay 42R2, and from pin 24Sh20 through contacts Zh6, Zh4 of the wiring panel contacts 4, 3 of relay 42R1-1 to contact 2 of the windings of time relay 42R2.

After heating up, the thermal time delay relay triggers and "ground" voltage is sent through its contacts 4, 3 to contacts 1 of the windings of relays 42R1 and 42R1-1. These relays trigger and:

- send +27 v through contacts 5, 3 of relay 42R1 to contacts 2, 5 of relay 42R25;

- through contacts 4, 3, break the 115 v 400 cps supply circuit to the windings of thermal relay 42R2;

-connect contacts 1 of the windings of relays 42R1-1 and 42R1 with the ground through contacts 6,7 of relay 42R1-1 and contacts 7, 8 of relay 42R-4-1.

After cooling of thermal time delay relay 42R2, its sliding contact returns to the initial position and "ground" voltage is sent through reclosed contacts 4, 5 of relay 42R2 to contact 1 of the windings of relay 42R25. This relay triggers since there are +27 v at contact 2 of its winding, sent through the contacts of relay 42 R1.

A voltage of +27 v is sent through contacts 5 and 3, which were closed in this process, of relay 42R25, contact A-36 of the wiring panel, and then through pins 34Sh20 and 9Sh15-1 respectively to toggle switch "Vys. vkl." in unit TsD-41UTPM and toggle switch"Vkl. vys." in unit TsD-48.

After switching on one of these toggle switches, + 27 v is sent through pin 37Sh20 (or through pin 10 Sh15-1) to pin 1Sh29 and then through unit TsD-29TPM, through pin 2Sh29, through pin 10Sh2 to the high-voltage relay in unit TsD-32K.

This network is used in unit TsD-29TPM for cutting in high voltage at the moment that high-frequency energy of the transmitter is switched from the antenna to the equivalent (and vice versa). The network is broken by the mechanism of unit TsD-29TPM when the wave-guide switch is in the intermediate position.

Scanning Mode

Phase 3 of the azimuth selsyn is connected to ground through normally closed contacts 3, 4 of relay 42R5 and contact 25Sh1. Phases 1 and 2 of the azimuth selsyn are sent through pins 24Sh10 and 23Sh10 in unit Ts-D-40TK. When the antenna reflector is deflected to the right and to the left, the selsyn voltage causes a change in the phase of the control voltage by 180°.

S-E-C-R-E-T

Azimuth control voltage from unit TsD-44TP is sent through pins 22Sh14, 23Sh14 to unit TsD-31TP and moves the antenna in azimuthal direction.

Voltage is sent through pins 11Sh1 and 8Sh14 from the azimuth tach generator to the azimuth magnetic amplifier in unit TsD-44TP.

Voltage is sent through pins 10Sh1 and 6Sh19 from the azimuthal sweep selsyn to unit TsD-46.

Elevation control voltage is sent from unit TsD-44TP through pins 26Sh14 and 27Sh14 to unit TsD-31TP and moves the antenna with respect to elevation.

"Ground" voltage is sent from toggle switch "Soprov." through pin 27Sh20 in unit TsD-41UTPM to contact 7 of relay 42R31.

Elevation selsyn voltage is sent to unit TsD-40TK rhrough pins 22Sh1 and 22Sh10.

Voltage from the elevation tach generator is sent to unit TsD-44TP through contacts 21Sh1 and 28Sh14.

"Jump" voltages for generating "Verkh-Niz" markers are sent from unit TsD-40TK to unit TsD-36 through pins 20Sh10 and 17Sh6.

The Ranging System Mode

The ranging system mode is established by supplying + 27 v either from the "Zakhvat" button through pin 14Sh20 or from unit TsD-48 through pin 8Sh16. This voltage is fed to contacts 2 of the windings of relays 42R5; 42R5-1; 42R5-2; and, in addition, to unit TsD-40TK through pin 10Sh10 for converting the unit to the DU mode.

The Automatic Tracking Mode

The automatic tracking (target lock-on) mode is established after supplying a "round" voltage from the automatic lock-on device in unit TsD-37 through pins 11Sh7; 46Sh20; the "Sbros" button; and pin 47Sh20 to contacts 1 of the windings of relays 42R6 and 42R6-1.

S-E-C-R-E-T

50X1-HUM

Limit Protection of the Movement of the Antenna in the Azimuthal, Elevation and Tilt Directions

When the antenna reflector is in the exrreme positions of its azimuthal or elevation movements, as well as in the extreme tilt positions, one of the limit microswitches in unit TsD-31TP triggers. A "ground" voltage is fed from the azimuthal or elevation switch to unit TsD-42 and the winding of relays 42R7 or 42R8 and 42R9 or 42R10 through, respectively, pins 8Sh1 and 9Sh1 and 5Sh1 or 6Sh1. From the tilt limit switch a "ground" voltage is generated in unit TsD-44TP and passes through pins 31Sh1 - 34Sh14 or 32S1 - 33Sh4, also to ghe winding of the limit protection relay.

The relay then triggers and shorts the plates of the IF amplifier through diodes D4 or D3 in the azimuth channel, D2 or D1 in the elevation channel, and corresponding diodes in the tilt channel in unit TsD-44TP. As a result there occurs a balancing of the currents in the IF amplifier of the corresponding channel, the control voltage becomes equal to zero, and antenna movement ceases.

The "Locked-on Beam" Mode

The locked-on beam mode is established by switching on the toggle switch marked "Zakr. luch" (locked-on beam) in unit TsD-41UTPM. This sends a "ground" voltage to contacts 1 of relays 42R6 and 42R6-1, the relays trigger, and switching occurs as explained previously; at the same time, relays 42R5, 42R5-1 and 42R5-2 are also switched in through contacts 4, 5 of relay 42R6.

The "locked-on beam" mode differs from the automatic tracking mode in that a "ground" voltage is <u>not</u> sent to pin 13Sh10, as a result of which unit TsD-40TK is not converted to the automatic tracking mode and the antenna is not controlled by the error signal.

The Scanning Mode in the Presence of Noise Interference

When noise interference of a certain intensity is present, $+27$ v is fed from unit TsD-26TK through pin 15Sh26:

-- through pin 10Sh19 to lamp "P" in unit TsD-34TPM;

-- through pin 42Sh20 to the set operating mode switch when it is in the "Pomekha" (noise) position;

-- to contact 3 of relay 42R26.

S-E-C-R-E-T

50X1-HUM

After the operating mode toggle switch on panel TsD-41UTPM has been placed in the "Pomekha" position, +27v is sent through pin 43Sh20 to contact 2 of the windings of relays 42R20 and 42R20-1, as well as to contact 5 of relay 42R26, to pin 11Sh3 for disconnecting the random pulse noise limiter in unit TsD-33, through normally closed contacts 7 and 8 of relay 42R21 and pin 13Sh3, to unit TsD-33 for switching in the filter capacitance of the ShARU IF amplifier.

Relays 42R20 and 42R20-1 trigger and perform the following functions:

-- contact 4 of relay 42R20 removes the trigger pulse $t_o + 5$" from pin 5Sh7 and sends it to pin 13Sh26, that is, removes the trigger pulse from unit TsD-37 and sends it to unit TsD-26TK;

-- contacts 7 and 8 of relay 42R20 break the circuit which sends the ShARU narrow gate pulse from unit TsD-25TK through pin 10Sh25 to unit TsD-33, through pin 9Sh3, and to unit TsD-26TK through pin 16Sh26;

-- contacts 7 and 6 of relay 42R20 close the circuit which sends the ShARU narrow gate pulse from unit TsD-25TK through pin 5Sh26 to unit TsD-33, through pin 9Sh3, and to unit TsD-26TK through pin 16Sh26;

-- contact 4 of relay 42R20-1 removes the + 150 v (stab.) voltage from pin 16Sh25 (disconnects the video amplifier supply of the integrating circuits) and sends this voltage to pin 32Sh26 (connects the circuit which forms the artificial target in unit TsD-26TK);

-- contact 7 of relay 42R20-1 removes the "ground" voltage from pin 9Sh6 (through normally closed contacts 4, 3 of relay 42R23-1 abd 7, 8 of relay 42R5), which leads to disruption of the receiver triggering process, and sends the "ground" voltage to contact 1 of the winding of relay 42R20-2.

The artificial target pulse is sent from unit TsD-26TK through pin 6Sh26, normally closed contacts 7 and 8 of relay 42R23, and pin 15Sh25.

The DU Mode in the Presence of Smooth Noise Interference

When smooth noise interference is present, the DU mode is engaged in the same manner as when a normal signal is present: + 27 v is sent from the "Zakhvat" button through pin 14Sh20.

S-E-C-R-E-T

Relays 42R5; 42R5-1; and 42R5-2 are energized and perform the commutating functions which were examined above. In addition, + 27 v is fed to contacts 6 and 2 of relay 42R20-2. Since a "ground" voltage is sent to contact 1 of relay 42R20-2, this relay triggers. This leads to the following:

-- a "ground" voltage is sent from unit TsD-26TK through closed contacts 4 and 5 of relay 42R20-2 to pin 46Sh20 and from there to the "Sbros" button and pin 47Sh20 to contacts 1 of relays 42R6 and 42R6-1. These relays perform the functions examined above;

-- a voltage of +27 v is sent through contacts 6 and 7 of relay 42R20-2 to contact 2 of the winding of relay 42R21, and + 27 v is taken from pin 31Sh26 in unit TsD-26TK for disconnecting the range search for the target (relay 26R7 in unit TsD-26TK releases and a negative voltage passes through its contacts to pin 14Sh25 and from there through pin 10Sh7 to unit TsD-37 for disconnecting the range search for the target); the voltage then passes through normally closed contacts 4 and 3 of relay 42R22, pin 19Sh3, to unit TsD-33 and the relay which changes the noise level of the receiver.

The Automatic Tracking Mode in the Presence of Noise Interference

After the antenna has been set at the zero position, a "ground" voltage passes from unit TsD-26TK through pin 20Sh26 to contact 1 of the winding of relay 42R21. Relay 42R21 triggers since +27 v is applied to contact 2 of its winding from contact 7 of relay 42R20-2.

The contacts of relay 42R21 perform the following functions:

-- contacts 3 and 4 break the circuit which supplies a range pulse from unit TsD-37 through pin 17Sh7 to unit TsD-33 through pin 14Sh3;

-- contacts 5 and 4 close the circuit which supplies a ShARU widegate pulse from unit TsD-26TK through pin 5Sh26 to unit TsD-33 through pin 14Sh3;

-- contact 7 of relay 42R21 removes + 27 v from pin 13Sh3 (disconnects the filter capacitance of the ShARU IF amplifier in unit TsD-33) and sends it to unit TsD-40TK through pin 25Sh10 to increase the gain of the error signal separation circuit.

Monitoring Radiation and Switching on the Photographic Unit

A voltage of + 27 v is taken from the toggle switch marked "Izluch." (radiation) on unit TsD-41UPTM and sent through pins 15Sh20 and 5Sh29 to the waveguide switch of unit TsD-29TPM. The switch triggers and + 27 v passes

through pin 7Sh29 from unit TsD-29TPM to contact 2 of relay 42R17. This relay triggers and + 27 v goes through its closed contacts 4 and 5 from pin 14Sh2 (when high voltage is present) to contact 2 of relay 42R24 and through pin 26Sh20 to the radiation monitoring lamp in unit TsD-41UTPM.

The relay triggers and + 27 v passes through its contacts 3 and 5 and pin 45Sh20 to unit BSYu for switching on the photographic unit.

Switching on the Monitoring Circuit

When toggle switch 41V3 is placed in the "kontrol'" (monitor) position, + 27 v is sent to unit TsD-42 for the operation of relays 42R23; 42R28; 42R28-1; 42R28-2; 42R29; 42R30; 42R31.

The sequence of operation of the above relays is presented in the description of the monitoring channel, section 12, part I of this book.

[redacted]

Connecting the TsD-48 Ground Testing Unit Panel and Switching On the Antenna Motors:

When panel TsD-48 is hooked up to the radar by means of plug 30Sh15, plus 27 volts are fed to the windings of motor-switching relays 42R14 and 42R14-I. The relays respond. Contacts 1 and 2 of relay 42R14 open the power circuit to the scanning motor: plus 27 volts, contacts 1, 2 of relay 42R14, plug 4ShI.

In this case, the scanning motor can be switched on by plus 27 volts supplied through plug 5Sh15 to plug 4ShI.

Contacts 4 and 5 of relay 42R14 open the power circuit of the control windings of the azimuth motor: plug 23Sh14; contacts 5, 4 of relay 42R14; plug 18ShI.

In this case, the azimuth motor is switched on as follows: the control voltage from plug 23Sh14, through contact GII of the distribution panel, plug 38Sh15, is fed to the toggle marked "Vkl. mot.A" (azimuth motor switch) in unit TsD-48 and, through this closed switch, to plugs 6Sh15 and 18ShI to the azimuth motor in antenna unit TsD-31TP. When the toggle marked "Vkl.mot.A" is switched off, the output of the azimuth magnetic amplifier is charged to the motor equivalent through plug 45Sh15.

Contacts 7 and 8 break the power circuit of the control windings of the elevation motor: plug 27Sh14; contacts 8 and 7 of relay 42R14, plug 20Sh1. In this case the elevation motor can be switched on by the control voltage supplied to the motor winding through plug 27Sh14, toggle "Vkl.mot.N" (elevation motor switch) in ground testing unit TsD-48, plug 19Sh15 and plug 20Sh1. When toggle "Vkl.mot.N" is switched off, the output of the elevation magnetic amplifier is charged with a load equivalent to the impedance of the motor through plug 41Sh15.

Contacts 3 and 4 of relay 42R14-1 break the power circuit of the magnetic amplifier of the stabilized Plus-150-v tilt voltage: contact A12 of the distribution panel; contacts 3 and 4 of relay 42R14-1; plug 1Sh14. In this case, the tilt magnetic amplifier can be switched on by plus 150 volts stabilized from toggle "Vkl.mot.krena" (tilt motor switch) in unit TsD-48, through plugs 37Sh15 and 1Sh14.

Switching RF-Voltage from the TsD-48 Ground Testing Unit Panel: The TsD-42 junction box provides the possibility of switching on the radar without switching on the modulator and magnetron heater in the TsD-32TK transmitter. From toggle "Vyk.nak.M" (magnetron heater switch) on the TsD-48 test panel, plus 27 volts are fed to the windings of relays 42R4 and 42R4-1 through plug 23Sh15. The relays respond.

50X1-HUM

[redacted]

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

[redacted]

Contacts 1 and 2 of relay 42R4 interrupt the 115 volts (600-900 cps) of the power circuit of transformer 32Tr-2: contact G37 on the distribution panel; contacts 1 and 2 of relay 42R4; fuse Pr3; contact E31 on the distribution panel; plug 22Sh2. The filament power to the high-voltage kenotrons is switched off. Contacts 4 and 5 of relay 42R4 disrupt the plus 27 volts from the aircraft power circuit to the filaments of the modulator tubes and the pressure-data unit in the TsD-32TK transceiver: contact 2 of contactor 42RII; fuse Pr16; resistors R1 and R2; contacts 4, 5 of relay 42R4; plug 4Sh2. Contacts 7 and 8 of relay 42R4 interrupt the power fed to transformer 32TrI-3 (through plug 21Sh2) and of transformer 32Tr2-3 (through fuse Pr6, plug 24Sh2). The -900-volt and 1,400-volt voltage rectifiers and the magnetron heater are switched off.

Contacts 3 and 4 of relay 42R4-I disrupt the power to the windings of the thermal time-delay relay.

Contacts 7 and 8 of relay 42R4-I interrupt the "korpus" (ground) circuit of the windings of relays 42RI-I and 42RI (provided this circuit was closed by contacts 6 and 7 of relay 42RI-I at the moment relay circuit 42R4-I closed).

Section 5. Design of the Junction Box Unit

Junction-box unit TsD-42 is specially designed to provide removal of the covers for access to equipment.

In the upper rear of the box are sockets Sh15, Sh15-I and Sh16 which connect up monitoring cables K15, K15-I and K-16 and panel of ground testing unit TsD-48, sockets Sh19 and Sh20, which connect cables 19F, 19-IF and 20F, which lead to outlets on the aircraft.

The following cables run through the upper part of the back wall of the box: cable 3 of receiver TsD-33, cable 6 of signal-forming unit TsD-36, cable 7 of ranging unit TsD-37, cable 10 of antenna control unit TsD-40, cable 25 of noise suppression unit TsD-25, and the cable from the fuse box. The following cables run through the front wall of the unit: cable I of antenna unit TsD-31TN, cable 2 of transceiver TsD-32TK, cable 14 of antenna tilt stabilization unit TsD-44TP, cable 26 of noise-interference indication unit TsD-26TK, cable 29 of antenna-equivalent unit TsD-29TNM and two shielded conductors to the control rheostat for magnetron current.

Inside, the wires lead to the distribution panels which are numbered in the horizontal direction and lettered in the vertical direction.

[redacted]

Type RES-9 and RES-10 relays are mounted on separate laminated plastic (pertinax) boards. The remaining components, such as relays, transformers, contactors, resistors R1 and R2, are mounted on the walls of the box.

A special box, which is connected to main box TSD-42 by a cable, contains the unit fuses Pr1 to Pr8 and Pr13 to Pr16, the potentiometers and receptacle G-1. The front of the box has openings to provide access to potentiometers R 11 and R 14.

On the housing of box TsD-42 there are four attachment lugs held to the shock-mounted frame by captive screws.

The fuse box is attached at the back of the frame with the face plate arranged vertically and facing opposite the direction of flight of the aircraft.

Chapter Twenty

THE SYNCHRONIZING UNIT (BSYu)

Section 1. General Characteristics of the Unit

The BSYu synchronizing unit is designed to operate in conjunction with the PAU-473-1 camera.

The unit starts the electric motor of the PAU-473-1 camera in the intermittent (still-photography) or motion-picture regime. This is done by producing a plus-27-volt pulse with a 30-80 microsecond duration every 2.2-2.8 seconds for the still-photography regime, or a continuous voltage of plus 27 volts in the continuous, motion-picture regime. Filter FBSYu suppresses interference from the spark-producing elements in the BSYu unit.

The unit draws plus 27 volts DC, 0.5 amp. It weighs 1.2 kilograms. The circuit diagram is shown in Figure 32.

Section 2. The Circuit of the Unit

When the input of the BSYU camera synchronizing unit is fed the commands "Vysokoye" (high) and "Proverka" (test), relay R3 responds to start the motor of the unit, which rotates a cam. The cam is designed to rotate once every 2.5 seconds, during which time the microswitch is closed for a period of 20-80 microseconds, when plus 27 volts are fed to the starter relay of camera PAU-473-I. The response of the relay draws from the output of the unit positive 27-volt pulses with a duration of 20-80 microseconds and a repetition rate of 2.5 seconds, thus starting the camera motor which is kinematically coupled with the shutter. When pulses are being transmitted from the BSYu Synchronizer, the motor in the camera moves the film in the cartridge, and the shutter remains open for the exposure period of 2.5 seconds, thus taking a photograph of the indicator screen. When the unit input is fed the command "Pusk" (start), relay R2 in the BSYu Synchronizer responds to shift the unit into the motion-picture mode. In this case, plus 27 volts are drawn from the output of the BSYu Synchronizer to run the electric motor in the camera continuously as long as the command "start" is in effect.

In the motion-picture mode, the exposure rate is 7-11 frames per second.

Operation of the Unit When the Command, "High" is Given for "Radiation":

Relays R1, R2, and R3 are de-energized. From the aircraft power circuit, 27 volts are fed to circuits 5Sh27-1Sh27. From the camera, contact 8 of the winding of relay R1 is fed ground potential through circuit 6Sh27, normally closed contacts 5 and 4 of relay R2, contacts 8 of the winding of R1, and then through normally closed contacts 2 and 1 of relay R1.

During operation on radiation, the command "Vysokoye" ("high") is sent from the radar control panel TsD-41UTPM to plug 7Sh27 and on to contact 7 of the winding of relay R3 in the form of a positive 27-v voltage. Relay R3 responds supplying through plug 5Sh27 and closed contacts 3 and 1 of R3 the plus 27 volts to the winding of electric motor M, which rotates cam K.

Periodically every 2.5 seconds cam K closes contacts 3 and 4 of microswitch V2 for a period of 20-80 microseconds, and the plus 27 volts are fed to contact 7 of the winding of relay R1.

Since "ground" is supplied to contact 8 of the winding of relay R1 from plug 6Sh27, and to normally closed contacts 5 and 4 of relay R2 from the camera, relay R1 responds and blocks circuit 5Sh27 (closed contacts 4 and 6 of relay R1) and contact 7 of the winding of relay R1 only during the period when contacts 3 and 4 of microswitch V2 are closed, that is for 20-80 microseconds.

The response of relay R1 opens its contacts 1 and 2 and, at the same time, breaks the grounding circuit of the electric motor of the photographic unit; plus 27 volts are fed through closed contacts 3 and 1 of relay R1 to plug 3Sh27 to start the motor of camera PAU-473-1, which then goes through its operation cycle.

A special cam in the photographic unit regulates the operating mode of relay R1.

At a specified time, the control cam in the camera closes microswitch V1; the closed contacts of this switch change the polarity of the voltage fed to Synchronizing unit BSYu, and plus 27 volts are fed through plug 6Sh27 to contact 8 of the winding of relay R1. R1 responds, closing its contacts 1 and 2 and feeding the plus 27 volts through plug 6Sh27 (normally closed contacts 5 and 4 of relay R2, contacts 2 and 1 of relay R1) and plug 3Sh27 to the winding of the electric motor of the camera. The control cam of the camera rotates and, at the correct moment, closes contacts 1 and 2 of microswitch V1, and "ground" is again connected to plug 6Sh27 and from there to contact 8 of relay R1.

The electric motor of the camera is grounded through circuits 6Sh27 (normally closed contacts 5 and 4 of relay R2, normally closed contacts 1

[redacted]

and 2 of relay R1) and 3Sh27. The control cam of the photographic unit begins to rotate and, at the right moment, closes contacts 1 and 2 of microswitch V1; ground potential is fed to 6Sh27 and from there to contact 8 of relay R1.

From circuits 6Sh27 (normally closed contacts 5 and 4 of relay R2, normally closed contacts 1 and 2 of relay R1) and 3Sh27, ground potential is fed to the winding of the electric motor of the photographic unit. At this moment the armature of the motor is shorted, which imparts a strong braking action.

The control cam in the kinematic linkage of the camera is arranged so that the braking and stopping of the electric drive motor will occur at the moment the camera shutter is open to the sector opposite the exposure aperture.

From the moment the motor stops until it starts up again the image on the screen is exposed on the film. When relay R1 of the BSYu Synchronizing unit receives the next pulse from microswitch V2, the operation of the electrical circuit is repeated.

The rotation of the electric motor in the BSYu Synchronizing unit and the feeding of pulses to relay R1 occur without interruption during each period of action of the command "high" during "radiation."

Operation of the unit upon the command "Proverka" (test):

The command "test" is used to test the functioning of the BSYu Synchronizer and PAU-473-1 camera without switching on the radar when the aircraft is on the ground.

When the input of circuits 1Sh27 and 5Sh27 are fed 27 volts, and circuit 8Sh27 is fed the command "test" (plus 27 volts), relay R3 responds. The rest of the operation of the circuit is the same as already described for the operation of the unit on command "high" during "radiation."

The BSYu and PAU-473-1 units (Synchronizer and camera) function only as long as the "Proverka" (test) button located on the back of the housing of the PAU-473-1 camera is depressed. When the "test" button is released, these two units cease to function.

Operation of the unit upon the command "Pusk" (start):

The command "start" follows the still-photography command. As a result of the preceding still-photography command, the motor in Synchronizing unit BSYu begins to rotate. The command "start" is fed to circuit 4Sh27 and on to contact 7 of the winding of relay R2; the relay responds, breaking its contacts 5 and 4 and, at the same time, breaking the power supply circuit

to relay R1 (contact 8), and the control cam of the camera. The plus 27 volts DC supplied through closed contacts 6 and 4 of relay R2 to contact 8 of the winding of relay R1 do not cause relay R1 to respond, because contact 7 of relay R1 gets only the positive pulse of the amplitude, equal to plus 27 volts, from microswitch V2. Thus the motor of Synchronizing unit BSYu does not control the operation of the camera in the motion-picture mode.

Plus 27 volts are fed through circuits 5Sh27 (closed contacts 6 and 4 of relay R2 and normally closed contacts 2 and 1 of relay R1) to circuit 3Sh27, and the electric motor in the camera operates continuously (motion-picture mode) during the time the command "start" is in effect. When relay R2 responds, it closes its contacts 3 and 1, which guarantees transmission of the response signal to circuit 9Sh27.

At the conclusion of the command "start" the unit begins to send circuit 3Sh27 trigger pulses which operate the PAU-473 camera in the intermittent (still-photography) mode.

Section 3. Design of the Unit

The BSYu Synchronizing unit is assembled in a cast metal housing 245 x 77 x 64 millimeters in size.

On the floor of the housing are the reduction gear and motor, micro-switch KV-9 and three relays.

The shaft of the motor is coupled kinematically with the shaft of the shaped cam in the ratio 1 : 291,666.

The response of microswitch KV-9 can be adjusted by shifting its mounting bracket, which is accessible through an oval opening in the housing of the reduction gear. The principal circuit diagram of the BSYu filter circuit is given in Figure 33 (see the collection of circuit diagrams).

Chapter Twenty-One

PAU-473-1 CAMERA PLUS FOCUSSING TUBE

Section 1. General Description

The camera is used to photograph the screen of indicator unit TsD-34TPM in the still-photography and motion-picture modes and to provide visual observation of the screen under both daylight and night conditions.

Visual observation is guaranteed by a device which continuously regulates the passage of light.

The photographing is done by camera PAU-473-1 in conjunction with the special focussing tube which contains an optical system.

The positive trigger pulses from the BSYu unit are used to start the photographic operation and to initiate the still-photography mode of photographing.

A DC voltage (plus 27 volts), likewise taken from the BSYu unit, initiates the photographic process in the motion-picture mode.

The objective of the photographic unit contains a 1:14 diaphram.

The unit also has a framing device which adjusts the optical system of the focussing tube so that the entire screen will be in the field of view of the objective.

The PAU filter suppresses the noise coming from the sparking elements of the camera.

Section 2. Main Technical Characteristics of the Camera:

1. Optical data:
   - objective focal length: 20 mm;
   - maximum aperture ratio: 1 : 5.6
   - field of view: 14°40' x 14°40';
   - resolution: not less than 20 lines per mm;
   - exposure: (motion-picture mode) 1/30 second.

S-E-C-R-E-T

50X1-HUM

2. Electrical data: DC power supply: 27 volts ± 10%;
electric heater: 27 volts;
total power requirement: not over 60 watts.

3. Design data: frame format: 10.5 x 10.5 mm;
length of film in cassette: 6 meters (570 frames);
photographing speed (motion-picture mode): 7-11 frames per second;
length of trigger pulse: 20-80 microsec;
interval between pulses: 2.2 - 2.8 seconds;
dimensions: 225 x 86 x 48.5 mm;
weight: 1.2 kg

The camera consists of:

1. electrical section;
2. mechanical section;
3. optical section;
4. electric heater.

The principal circuit diagram for this camera unit is given in Figure 34. (See collection of circuit diagrams)

Section 3. Operation

Intermittent (still-photography) Mode: The initial conditions of the electrical circuit: electric motor M shorted with its pole output connected (shorted) to ground through circuits 1Sh26 (contacts 1 and 2 of microswitch V1), 7Sh26 (normally closed contacts 5 and 4 of relay R2 and normally closed contacts 1 and [1] of relay R1), 3Sh27 and 3Sh26.

When the electric motor in the BSYu unit starts up as a result of the command (depression of button) "Vysokoye" ("high") on "Izlucheniye" (radiation), cam K, by pressing against microswitch V2, closes contacts 3 and 4, and plus 27 volts are fed from the aircraft power circuit to contact 7 of the winding of relay R1. Relay R1 responds, closing its contacts 1 and 3 and disrupting the shorting circuit of electric motor M in the camera unit.

The 27 volts from the aircraft power circuit go through the closed contacts 3 and 1 of relay R1 to the input plug 3Sh26 of the camera unit and on to the winding of electric motor M. The motor begins to turn over and rotates shaped cam K which is kinematically coupled to it. Cam K closes contacts 3 and 4 of microswitch V1 for a given time (0.1 second), and circuit 7Sh26 is fed the response signal in the form of the DC voltage of plus 27-v. This voltage from circuit 7Sh26 is fed to 6Sh27 in the BSYu

50X1-HUM

Sanitized Copy Approved for Release 2011/03/31 : CIA-RDP82-00038R001800190001-3

50X1-HUM

Synchronizing unit and on to contact 8 of the winding of relay R1. Relay R1 de-energizes, disrupting the plus 27 volts to the power circuit (5Sh27 and contacts 3 and 1 of relay R1) of the armature of the electric motor. The electric motor and the cam coupled to it rotate by inertia only as long as it takes the contacting plates to move from the normally open contacts to the normally closed contacts.

Then the plus 27 volts are fed to input circuit 3Sh26 of the camera unit through circuits 2Sh26 (contacts 4 and 3 of microswitch V1), 7Sh26, 6Sh27 (normally closed contacts 5 and 4 of relay R2 and normally closed contacts 2 and 1 of relay R1), and 3Sh27. The electric motor M continues to operate until cam K closes contacts 3 and 4 of microswitch V1.

Whereas cam 4 opens contacts 3 and 4 of microswitch V1, contact 1 and 2 of microswitch VI close, and input circuit 3Sh26 of the camera unit is fed once more a voltage of minus 27 v through circuits 1Sh26 (contacts 1 and 2 of microswitch V1), 7Sh26, 6Sh27 (normally closed contacts 5 and 4 of relay R2 and closed contacts 2 and 1 of relay R1), 3Sh27, and the electric motor in the photographic unit is shorted, which imparts an abrupt braking action.

The method of dynamic braking the electric motor by shorting the armature is used as a fast braking of the motor in order to set the shutter accurately.

In this braked condition, the electrical circuit of the camera unit is prepared to receive the next trigger pulse, which will repeat the operation of the circuit.

This concludes the operation of the photographic cycle.

Cam K in the kinematic linkage of the camera unit is arranged so that the braking and stopping of the electric drive motor will occur at the moment the shutter is open to the sector opposite the exposure aperture. From the moment the motor stops until it starts again, the image on the screen is exposed on the film.

The length of exposure (exposure of a frame) is determined by the interval between the trigger pulses of the camera unit.

The Continuous Photographing Mode (motion-picture mode):

Upon the command "pusk" ("start"), which is given in the form of a plus-27-volt voltage, relay R2 in the BSYu unit energizes and shifts the camera into the motion-picture mode of operation.

S-E-C-R-E-T

50X1-HUM

The energizing of relay R2 opens contacts 5 and 4 of relay R2 and interrupts the circuit that shorts the armature of the electric motor in the camera unit.

The plus 27-v are fed without interruption through circuits 5Sh26 (closed contacts 6 and 4 of relay R2 and contacts 2 and 1 of relay R2), 3Sh27 and 3Sh26 to the input of the camera unit and on to the winding of the electric motor.

The electric motor operates continuously as long as the command "pusk" is in effect.

The continuous turning of the electric motor of the camera provides a photographing of the screen at a rate of 7-11 frames per second (motion-picture mode).

When the command "pusk" terminates, the electrical circuit of micro-switch V1 in unit BSYu is re-energized; then, when the unit receives the trigger pulse, the camera will operate in the intermittent (still-photography) mode.

The camera shuts off along with the BSYu synchronizing unit with the removal of the command "Vysokoye" (high). The response signal is registered only when the camera is operating in the motion-picture mode.

The "Proverka" (test) Mode:

Use the button marked "Proverka" (test) to test the functioning of the camera when the aircraft is on the ground. This button is located on the back wall of the camera housing.

When the "Proverka" button is depressed, the plus 27 volts from the aircraft power circuit are fed to circuit 6Sh26 and then to input circuit 8Sh27 and on to contact 7 of relay R3 in the synchronizing unit BSYu to start the electric motor. As a result, the BSYu unit begins to send out trigger pulses with a duration of from 20 to 80 microseconds and a repetition rate of 2.2 to 2.8 seconds. The camera and synchronizing unit BSYu operate in the intermittent (still-photography) mode. When the "Proverka" button is released, units BSYu and PAU-473-1 cease to function.

To test the operation of the camera in the motion-picture mode, depress the button marked "pusk" (start). The camera will operate in the motion-picture mode as long as the starting relay is blocked.

Suppression of radio interference:

Radio interference is eliminated from electric motor M and microswitch V1 by means of capacitors C1 and C2, located inside the PAU-473 camera and by means of secondary filter box FPAU containing capacitors. The box is 100 x 72 x 49 millimeters in size.

The electrical circuit diagram of the FPAU filter box is shown in Figure 35 (see the collection of circuit diagrams).

The camera unit consists of the following main parts:

1. the PAU-473-1 camera;
2. cartridge;
3. focussing device;
4. optic; and
5. electric heater.

The Camera:

The "photomonitoring instrument" is a rectangular camera, 225 x 86 x 48.5 millimeters.

It consists of a housing and cover. A cutout with a hinged cover is used to load the camera with a film cartridge. The cover locks shut. The front of the camera contains the objective, and the back has the plug-and-jack assembly.

Inside the camera are an electric motor attached to a plate, a thermostat, heater, the film-moving mechanism, shutter, microswitch KV-9, a gear to transmit the motion from the motor to the differential, and gears to transmit the motion from the differential to the shutter and to the maltese cross. On the pin of the maltese cross there is is gear to transmit the intermittent motion to the camera mechanism. Springs on the cover and on a platen hold the film cartridge in the operating position, that is in the position where the emulsion layer of the film will be in the focal plane of the objective.

The Film Cartridge:

The film cartridge is a pressed opaque housing with a cover. The gears are outside the cartridge.

The Viewfinder:

The optical system in the viewfinder consists of a 6-power microscope to enlarge the image produced by the objective in the plane of the film and a grating superimposed on the flat side of a combination piece. The field of view of the optical system is in the form of a circle 11 millimeters in diameter.

The optical system consists of the following: The combination piece with cross lines at the frame aperture; mirror with external reflection; objective, eyepiece.

The optical system of the viewfinder affords the possibility of viewing for any degree of rotation of the combination piece within the limits of adjustment of the camera on the photographed object.

The eyepiece of the viewfinder can be moved axially to accommodate the eye of the observer (refractive viewing).

Tube With Optical System:

The tube with the optical system consists of:

1. protective cap
2. housing
3. polaroid cassette
4. combination light filter.

The protective cap is made of perforated rubber with inside coating of velvet black. A rubber washer provides a tight fit of the light filter to the housing and prevents the intrusion of light into the inside of the cap.

Inside the housing are the combination light filter and mirror. In the cover there are three adjusting screws for positioning the mirror in such a way that the entire field of the indicator screen will be in the field of view of the objective.

The polaroid cassette is in the form of a moveable piece containing a polaroid light filter protected against damage on both sides by protective glass attachments.

The rim of the moveable piece has a gear link to regulate the amount of light passage. The rim has the letters "D", "N", and "S" marked in red; these marking correspond to the maximum ("D") and minimum ("N") passage of light. The marking "S" indicates the recommended position of the polaroid for observation at dawn and dusk.

The tube with the optical system is attached to the indicator by four latches.

Chapter Twenty-Two

TsD-48 GROUND TESTING AND MONITORING PANEL

Section 1. Function of the Panel

The TsD-48 unit, ground testing panel, is used to check the main parameters of the radar during operation on the ground in conjunction with the TsD-41UTPM radar control panel. The ground testing panel has control instruments for the following operations:

1. switching the radar on and off;
2. switching the high voltage on and off;
3. switching the magnetron and receiver filament circuits on and off;
4. switching the phantom target signal on and off;
5. switching the azimuth, elevation, tilt and scanning motors on and off;
6. switching the VTsD-30 altitude simulator signal on and off;
7. switching the DU ranging system on and off;
8. switching the TsD-32TK transceiver from the manual AFC-klystron (RRChK) mode to the automatic AFC-klystron (APChK) mode;
9. switching the RF radiation from antenna to equivalent;
10. checking the calibration of the TsD-34TPM indicator according to the phantom target signal with fixed delay;
11. checking the current to the TM magnetron;
12. checking the 115-volt, 400-cycle and 110-volt, 600-900-cycle AC and the 27-volt DC supplies;
13. checking the rectified stabilized voltages: plus 300 volts st; - 250 volts st; plus 150 volts st;
14. checking the feedback current for tilt;
15. checking the balance of the magnetic amplifiers for azimuth, elevation and tilt;
16. checking the balance of the DC amplifiers for azimuth, elevation and tilt in the TsD-40TK antenna control;
17. checking the voltage on the stator windings of the azimuth, elevation and tilt selsyns Sn5;
18. checking the voltage of the RRChK manual klystron frequency control;
19. checking, with the indicator lamps, the commands issued to the radar:

    a) with the high voltage switched on;

50X1-HUM

b) with antenna radiation switched on;
c) upon the signal "break off attack."

20. The following signals and voltages are checked at the test outlets on the front panel of the unit:

a) crystal-III current;
b) noise and video signal at output of the TsD-33 receiver;
c) voltage of the 31Sn5 tilt return-to-zero selsyn;
d) voltage of the azimuth reference voltage generator;
e) pulse of the output blocking oscillator from TsD-25TK noise suppression unit;
f) error signal voltage from the TsD-40TK antenna control unit;
g) 115-volts, 400 cps from the PO-1500 voltage converter; 115 volts, 600-900 cps; plus 27 volts; plus 150 volts stabilized; plus 300 volts stabilized; plus 250 volts stabilized; minus 250 volts stabilized;
h) phantom target signal (positive and negative polarity);
i) trigger pulse of TsD-32TK transceiver;
j) voltage from the stator windings of the azimuth and elevation selsyns in the TsD-31TP antenna unit.

Section 2. Technical Data

1. The unit checks the supply voltages: 115 (±4%) volts, 400 (+28, -20) cps, from the PO-1500 voltage converter (whereby 250 microamps indicated on instrument on ground testing unit TsD-48); 115 (±3%) volts, 600-900 cps, from the variable-frequency generator; and 27 (± 10%) volts from the aircraft power circuit.

2. The unit checks the rectified voltages: +300 (± 3) volts stabilized; + 250 (± 2) volts stabilized; and +150 (± 2) volts stabilized.

When all supply and rectified voltages are being measured, the indications of the IP meter of the ground testing unit TsD-48 are adjusted to equal 250 (± 5) microamps.

3. The unit checks the 13.5 (± 25) amperes current of the TM magnetron, which corresponds to an indication of the IP meter in divisions numerically equal to the magnetron current.

S-E-C-R-E-T

50X1-HUM

4. The unit checks the currents of crystals I, II, and III, which should be within the limits 0.2 to 1.6 milliamperes (corresponding to an IP meter reading on the TsD-48 test unit of 20 to 160 microamps).

5. The unit checks the voltages from the outputs of the DC amplifiers for azimuth, elevation and tilt, as well as the tilt feedback voltage.

6. The unit supplies to plug 7Sh15-2 and to the IP meter the RRChK (manual klystron frequency control) voltage within the limits -100 to -240 volts (100-240 microamps on the IP meter).

7. The unit supplies to the test outlets marked "Vykhod TsD-33" (Output of receiver TsD-33) and "Signal " (positive signal), and supplies to plug 8Sh15-2 a phantom-target signal pulse of positive polarity 0-30 volts and repetition rate T9 in the scan mode and T19 in the aiming mode, and to the outlet marked "Signl. " (negative signal) a pulse of negative polarity and 30-volt amplitude with the same repetition rates.

   The phantom-target signal can be modulated with frequency T30.

8. The unit is supplied with the 31Sn6 selsyn feed voltage from TsD-44TP (magnetic amplifier and antenna tilt stabilization unit), which can be used in conjunction with the two-way switch marked "Kren-P - Kren-L" (Tilt-R - Tilt L) to check the functioning of the tilt channel.

9. To the test outlets marked "TK-III", "Nap. GON" (voltage-reference-voltage generator) "Imp.zad.bl.gen.TsD-25" (pulse trailing-edge blocking oscillator TsD-25), "Zapusk TsD-32" (start transmitter TsD-32), "Imp.TsD-31" (pulse antenna TsD-31) and to the RF outlet on the SP-104 (noise tracking unit) the unit supplies pulses and voltages which are rectified in the radar and fed directly to the test outlets and the RF outlet.

10. The unit operates on voltages supplied from the radar when cables 15-1k, 15-2k and 16k are hooked up, the required currents being supplied by the power source:

   1. 115 volts (plus-minus 3%), 400 cps, 0.4 amp from the AC network;

   2. plus 250 volts stabilized... -0.02 amp; minus 250 volts stabilized... -0.002 amp; plus 300 volts stabilized... -0.002 amp from the rectified voltage sources.

Section 3. Unit Design

The unit is designed in the form of a unit housing, rectangular in shape, with removeable back wall. The inside front and side walls hold all the parts and circuit components, plus a panel containing the electron tubes.

On the left side wall are the three plug-and-jack assemblies, Sh15-1, Sh15-2 and Sh16.

The front of the housing has the IF meter, instrument lamp, four signal lamps, 25 test outlets and the following test instruments:

1. 5-position switch P1, 5-position switch P2, 11-position switch P3, 8-position switch P4, 5-position switch P5;

2. knobs: "Zaderzhka" (delay), "Amplit.sign." (signal amplitude) and "Napr.RRChK" (manual klystron frequency control voltage);

3. 18 toggle switches;

The unit dimensions are 580 x 297 x 200 millimeters.

The unit weighs less than 30 kilograms, including the cables.

When it has been removed from the housing, the radar can be hooked up by cables 19 and 20, the circuits of which are shown in figures 36 and 37 (see collection of circuit diagrams). The principal circuit diagram of the TsD-48 ground testing unit is given in Figure 38 (see book of diagrams).

-END-

S-E-C-R-E-T